



2013-12

A business case analysis of pre-positioned  
expeditionary assistance kit joint capability  
technology demonstration

Lee, Hui Hyang

Monterey, California: Naval Postgraduate School

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# **NAVAL POSTGRADUATE SCHOOL**

**MONTEREY, CALIFORNIA**

## **THESIS**

**A BUSINESS CASE ANALYSIS OF PRE-POSITIONED  
EXPEDITIONARY ASSISTANCE KIT JOINT CAPABILITY  
TECHNOLOGY DEMONSTRATION**

by

Hui Hyang Lee

December 2013

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<b>REPORT DOCUMENTATION PAGE</b>			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.				
<b>1. AGENCY USE ONLY (Leave blank)</b>		<b>2. REPORT DATE</b> December 2013	<b>3. REPORT TYPE AND DATES COVERED</b> Master's Thesis	
<b>4. TITLE AND SUBTITLE</b> A BUSINESS CASE ANALYSIS OF PRE-POSITIONED EXPEDITIONARY ASSISTANCE KIT JOINT CAPABILITY TECHNOLOGY DEMONSTRATION			<b>5. FUNDING NUMBERS</b>	
<b>6. AUTHOR(S)</b> Hui Hyang Lee				
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Naval Postgraduate School Monterey, CA 93943-5000			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> N/A			<b>10. SPONSORING/MONITORING AGENCY REPORT NUMBER</b>	
<b>11. SUPPLEMENTARY NOTES</b> The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB protocol number: <u>N/A</u>				
<b>12a. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited			<b>12b. DISTRIBUTION CODE</b> A	
<b>13. ABSTRACT (maximum 200 words)</b> <p>The Pre-Positioned Expeditionary Assistance Kit (PEAK) is a Joint Capability Technology Demonstration initiative that is being managed by the Office of the Secretary of Defense, developed in partnership with the National Defense University, and is sponsored by United States Southern Command.</p> <p>This study analyzes the costs and benefits of implementing the PEAK as a new capability into the Humanitarian Assistance/Disaster Relief Operational community with the objective of building key capacity in partner nations to promote security and stability and focusing on providing effective, low-cost and sustainable capabilities. This thesis conducts a Business Case Analysis (BCA), including a base case analysis and sensitivity analyses focusing on the Return on Investment (ROI) of investing in, and operating and maintaining, the PEAK.</p> <p>The BCA compares the life-cycle cost estimate of the PEAK with that of the status quo (existing) systems in operational scenarios for a 10-year period. When compared against the estimated investment over the system life-cycle, the results show positive ROI and net present value after the first year. The savings come from the cost of water and transportation.</p>				
<b>14. SUBJECT TERMS</b> Business Case Analysis (BCA), Pre-Positioned Expeditionary Assistance Kit (PEAK), Return of Investment (ROI), Net Present Value (NPV), Life-Cycle Cost Estimate (LCCE)			<b>15. NUMBER OF PAGES</b> 105	
			<b>16. PRICE CODE</b>	
<b>17. SECURITY CLASSIFICATION OF REPORT</b> Unclassified	<b>18. SECURITY CLASSIFICATION OF THIS PAGE</b> Unclassified	<b>19. SECURITY CLASSIFICATION OF ABSTRACT</b> Unclassified	<b>20. LIMITATION OF ABSTRACT</b> UU	

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**A BUSINESS CASE ANALYSIS OF PRE-POSITIONED EXPEDITIONARY  
ASSISTANCE KIT JOINT CAPABILITY TECHNOLOGY DEMONSTRATION**

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Submitted in partial fulfillment of the  
requirements for the degree of

**MASTER OF SCIENCE IN OPERATIONS RESEARCH**

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## **ABSTRACT**

The Pre-Positioned Expeditionary Assistance Kit (PEAK) is a Joint Capability Technology Demonstration initiative that is being managed by the Office of the Secretary of Defense, developed in partnership with the National Defense University, and is sponsored by United States Southern Command.

This study analyzes the costs and benefits of implementing the PEAK as a new capability into the Humanitarian Assistance/Disaster Relief Operational community with the objective of building key capacity in partner nations to promote security and stability and focusing on providing effective, low-cost and sustainable capabilities. This thesis conducts a Business Case Analysis (BCA), including a base case analysis and sensitivity analyses focusing on the Return on Investment (ROI) of investing in, and operating and maintaining, the PEAK.

The BCA compares the life-cycle cost estimate of the PEAK with that of the status quo (existing) systems in operational scenarios for a 10-year period. When compared against the estimated investment over the system life-cycle, the results show positive ROI and net present value after the first year. The savings come from the cost of water and transportation.



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## LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACTD	Advanced Concept Technology Demonstration
AOF	Area of Focus
AOR	Area of Responsibility
ATD	Advanced Technology Demonstration
AUC	Average Unit Cost
BCA	Business Case Analysis
COCOM	Combatant Command
CRED	Centre for Research on the Epidemiology of Disasters
DAU	Defense Acquisition University
DoD	Department of Defense
DRC	Democratic Republic of Congo
DUSD (AT)	Deputy Under Secretary of Defense (Advanced Technology)
EIP	End Item Procurement
EM-DAT	Emergency Events Database
ESM	Energy Surety Microgrid
FEMA	Federal Emergency Management Agency
FM&C	Financial Management and Comptroller
FYDP	Future Years Defense Program
GPS	Global Positioning System
HA/DR	Humanitarian Assistance / Disaster Response
HFN	Hastily Formed Network
HMMWV	High-Mobility Multipurpose Wheeled Vehicle
ISU	Internal Airlift/Helicopter Slingable-Container Unit
JCIDS	Joint Capabilities Integration and Development System
JCS	Joint Chiefs of Staff
JCTD	Joint Capability Technology Demonstration
JTF-B	Joint Task Force - Bravo
KW	Kilowatt
KWH	Kilowatt Hour



LCC	Life-Cycle Cost
LCCE	Life-Cycle Cost Estimate
LWP	Lightweight Water Purifier
MAGIC	Medium Altitude Global ISR Communication
NCCA	Naval Center for Cost Analysis
NDU	National Defense University
NEST	New Energy System Technologies
NM	Nautical Miles
NPS	Naval Postgraduate School
NPV	Net Present Value
O&S	Operation and Support
OASD (FM&C)	Office of the Assistant Secretary of Defense (Financial Management & Comptroller)
OFDA	Office of U.S. Foreign Disaster Assistance
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense
PEAK	Pre-positioned Expeditionary Assistance Kit
PKO	Peacekeeping Operations
POL	Petroleum, Oil, and Lubricants
POR	Program of Record
PV	Present Value
QDR	Quadrennial Defense Review
R&D	Research and Development
ROI	Return on Investment
S&T	Science and Technology
SATCOM	Satellite Communications
SMS	Short Message Service
SPIDERS	Smart Power Infrastructure Demonstration for Energy Reliability and Security
UAV	Unmanned Aerial Vehicle
U.S.	United States

USAID	United States Agency for International Development
USAFRICOM	United States Africa Command
USPACOM	United States Pacific Command
USSOUTHCOM	United States Southern Command
WASH	Water, Sanitation, and Hygiene
WBS	Work Breakdown Structure

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## EXECUTIVE SUMMARY

The Pre-positioned Expeditionary Assistance Kit (PEAK) is a Joint Capability Technology Demonstration initiative that is being managed by the Office of the Secretary of Defense, developed in partnership with the National Defense University, and is sponsored by United States Southern Command. This program seeks to enhance stability and promote national security by demonstrating and transitioning an array of capabilities to field distributed essential services including potable water and power generation, communications, and situational awareness during periods of distress.

This study analyzes the costs and benefits of implementing the PEAK as a new capability into the Humanitarian Assistance/Disaster Relief (HA/DR) Operational community with the objective of building key capacity in partner nations to promote security and stability and focus on providing effective, low-cost and sustainable capabilities. This thesis conducts a Business Case Analysis (BCA), including a base case analysis and sensitivity analysis focusing on the Return on Investment (ROI) of investing in, and operating and maintaining, the PEAK.

The BCA compares the Life-Cycle Cost (LCC) and benefit estimates of the status quo (existing) systems with the PEAK over a 10-year base case scenario. The analysis considers both a base case and several sensitivity analyses. The results are:

- PEAK provides enhanced ability of net assessment, supports HA/DR operations, and promotes security and stability in theater.
- The Life-Cycle Cost Estimate (LCCE) for acquiring and operating the status quo is \$655.5K, while the PEAK system is \$1,378.3K.
- The Net Present Value (NPV) of the PEAK in the base case scenario is \$5,211.6K. This positive value indicates the attractiveness of an investment in the PEAK.

- All PEAK investment costs are recouped after the first year of operation. The system has a positive ROI of 559% over 10 years.
- Increased use of the PEAK generates increased savings. These savings can be achieved by expanding use among Combatant Commands (COCOMs) or by increasing the density of the PEAKs within a COCOM.
- The savings come from cost of water and transportation. Water savings occur because the PEAK replaces the water costs that would normally occur, under the status quo, during an initial period of a disaster.

LCC and benefit estimates show that the PEAK system offers the U. S. Department of Defense (DoD) positive ROI and NPV after the first year of using one PEAK system in an operational scenario of 10 years. Using the PEAK will save money and reduce time to administer basic services such as water and communications, compared to the status quo. The PEAK provides effective and sustainable services in support of U.S. operations and promotes security and stability in theater.

## **ACKNOWLEDGMENTS**

I would like to thank my thesis advisor, Dr. Daniel A. Nussbaum, for his wisdom, patience, and guidance. Without him, this thesis would not have been possible. In addition, I would like to thank my thesis second reader, CDR (ret) Kevin Maher, USN, for his valuable inputs to this research. Most importantly, I would like to thank my family for their constant support and inspiration. Thank you all very much.

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# **I. INTRODUCTION**

## **A. PURPOSE OF THE STUDY**

The Pre-positioned Expeditionary Assistance Kit (PEAK) is a Joint Capability Technology Demonstration (JCTD) initiative that is managed by the Office of the Secretary of Defense (OSD), developed in partnership with the National Defense University (NDU), and sponsored by United States Southern Command (USSOUTHCOM). The technical manager for this program is NDU's Center for Technology and National Security Policy. This program seeks to enhance stability and promote national security by demonstrating and transitioning an array of capabilities to the field of operation. These capabilities are potable water and power generation, communications, and situational awareness (Office of the Secretary of Defense (OSD), 2010b).

The PEAK program intends to address the challenge that the military faces in providing critical services like clean water, power, and communications in support of distressed populations during a natural or human-made crisis while incorporating renewable energy systems. The PEAK initiative conducted a three-spiral “build – test – demonstrate” program during FY10 and FY12. Spiral 1 focuses on rapidly delivering integrated water filtration and power kits. It provides desalination & power units to USSOUTHCOM, United States Africa Command (USAFRICOM) and United States Pacific Command (USPACOM). Spiral 2 delivers a selection of technical solutions that address the four component capabilities; these components are potable water, power, communication, and situational awareness. Spiral 2 provides an integrated prototype kit to USSOUTHCOM at Joint Task Force-Bravo (JTF-B), Honduras. Spiral 3 delivers an integrated kit that satisfies four objective capabilities. The four objective capabilities are water desalination, information sharing, communications, and hybrid renewable power. Spirals 1 and 2 are identified as an interim capability, while Spiral 3 is identified as a mature capability. This study focuses on Spiral 3,



where the PEAK is integrated in an Internal Airlift/Helicopter Slingable-Container Unit (ISU) 60 container.

The purpose of this study is to analyze the costs and benefits of implementing the PEAK as a new capability into the Humanitarian Assistance/Disaster Relief (HA/DR) Operational community. The objective of the PEAK is to build key capacity in partner nations to promote security and stability. The focus is on providing an integrated kit that satisfies the four objective capabilities. This thesis conducts a Business Case Analysis (BCA), including a sensitivity analysis, focusing on the Return on Investment (ROI) of investing in, and operating and maintaining, the PEAK.

The BCA compares the time-phased, discounted cash flows of the PEAK with that of the status quo (existing) system. The result provides financial evidence of whether it makes business sense to proceed with investing in, and operating and sustaining, the PEAK. The PEAK is unique because it combines multiple capabilities, and there is no current single device which provides the PEAK-like capability. However, there are individual existing devices that provide only one of the PEAK's capabilities. Therefore, this combination of current devices is used as the base case from which to quantify the improvement provided by investing in and operating the PEAK.

## **B. THREATS TO STABILITY AND SECURITY**

Within the United States government, the Department of Defense (DoD) is a key organization with the global reach and breadth of capabilities to provide an immediate response to distressed populations. The DoD has been involved in disaster responses in the past, but now has decided to take a leading role in disaster response efforts throughout the globe. DoD has become a leader in initial response efforts (Chairman of the Joint Chiefs of Staff, 2011). Current policy states that, "stability operations are a core U.S. military mission that the DoD shall be prepared to conduct with proficiency equivalent to combat operations" (Department of Defense Instruction 3000.05, 2009). HA/DR

operations is one of six expanded core capabilities for the Navy, Marine Corps, and Coast Guard enumerated in "A Cooperative Strategy for 21st Century Seapower" (Department of the Navy, 2007). This represents a strategic shift from traditional hard power assets to the soft power effects.

Building security and stability with partner nations is vital in today's military power. The Quadrennial Defense Review (QDR) Report identified "building the security capacity of partner states" as a mission area growing in importance (Secretary of Defense, 2010). The PEAK is the first attempt to address United States defense capability shortfalls identified in the QDR within the "building security capacity" key mission area. Additionally, the 2011 National Military Strategy of the United States of America calls for the Combatant Commands to pursue security cooperation and to help strengthen the defense capabilities of allies and regional partners to support and advance United States interests (Chairman of the Joint Chiefs of Staff, 2011).

The unpredictable nature of disasters poses a challenge to the HA/DR process. The HA/DR process begins with the Combatant Commanders in coordination with United States Agency for International Development (USAID). First, the United States commits to a formal disaster relief operation when the disaster is beyond the ability of the host nation to handle on its own. Second, the host nation formally requests assistance from the United States. Third, the United States approves the request if it is in the strategic interests of the United States. Finally, USAID Office of United States (U.S.) Foreign Disaster Assistance (OFDA) provides the ambassador \$50,000, with the option to increase the amount to \$100,000. Additionally, the COCOM authorizes the immediate response of DoD units deployed in the area (Department of Defense Instruction 3000.05, 2009).

HA/DR operations includes facilitating the distribution and restoration of basic human services, providing medical support, conducting critical engineering operations, and providing necessary enabling security in order to alleviate human suffering and provide the foundation for the long term recovery of the disaster

area. Synchronizing DoD support to OFDA, USAID, and United Nation HA/DR efforts to mitigate human suffering and accelerate recovery in the affected area is the key to success of the HA/DR process. Without the knowledge of when or where disasters will occur, it is necessary to predict needs and to dedicate assets to service those needs. Without these dedicated assets during periods of distress, the security and stability of partner nations can be undermined by the lack of capacity to provide or maintain essential services.

Notwithstanding the increasing effort to build security capacity of partner states, there is still a gap in capabilities to support the United States and enhance partner nations in carrying out key missions (Horn, 2011). Some capabilities can be pre-positioned to help provide sustainable and essential services in time sensitive events. The PEAK project was initiated to address part of this gap. The project will contribute to DoD and other United States government efforts in building security capacity through collaboration with foreign authorities.

The PEAK services can be provided in support of a variety of missions, including support for HA/DR activities, peacekeeping operations (PKO), and assistance to civil law enforcement and first responder authorities.

### **C. PROBLEM STATEMENT**

The capacity of USSOUTHCOM, USPACOM, and USAFRICOM for promoting security and enhancing stability within their respective geographic Area of Responsibility (AOR) is constrained by a limited capacity for enabling scalable critical services during time-sensitive HA/DR events (United States Southern Command, 2010a). USSOUTHCOM's Area of Focus (AOF) is a region comprising 41 countries and territories across Central America, South America, and the Caribbean partner nation military and security forces. This area requires a wide range of capabilities to ensure security and enhance stability. One pervasive area of need in which to build partner nation capacity is distributed essential services. Regional security and stability can be threatened by the

absence of critical services that are enabled by potable water and power generation, information sharing, and communications. Additionally, the lack of appropriate U.S. response may create a national strategy gap and opportunities for potential adversaries.

Authority in-theater often lacks the capacity to develop essential services in times of crisis. DoD and partner nations can improve their ability to provide critical services for targeted purposes during the first days of a natural crisis through a structured process. Additionally, the DoD can help partner nations enhance their capabilities to carry out key missions through proactive military-to-military engagement. These collaborative efforts can contribute to regional stability.

The objective of the PEAK is to demonstrate and transition an array of capabilities to the field of operations. Demonstrating the PEAK's capabilities is the solution to ensuring security and enhancing stability. Each component of the PEAK can be used separately or as part of an integrated system designed to be deployed quickly to disaster environments, where the relevant services are not otherwise immediately available. An integrated PEAK is shown in Figure 1; the integrated PEAK contained in an ISU 60 container is shown in Figure 2 (Office of the Secretary of Defense (OSD), 2010a). The integrated PEAK system contained in an ISU 60 container is transportable via military and civilian air, sea, and land modes. The complete kit and associated consumables are able to fit on a single 463L Cargo Air Pallet.



Figure 1. Integrated System of the PEAK (from Office of the Secretary of Defense (OSD), 2010a)



Figure 2. The PEAK Contained in an ISU 60 Container (from Office of the Secretary of Defense (OSD), 2010a)

The benefit of this thesis and BCA is to provide decision makers in OSD with an objective, quantitative analysis of the cost-benefits of the PEAK JCTD and its status quo alternative. In addition, this thesis will support the decision process for OSD as it embarks on an effort to provide effective, low-cost, and sustainable services in support of US operations, and will help build key capacity in partner nations to promote security and stability in the theater. The BCA will

evaluate the costs, benefits, and ROI of the PEAK JCTD, as compared to the current systems.

Implementing the PEAK capabilities as a support to the HA/DR operations is vital to the DoD's mission. For these reasons, estimating the quantifiable and non-quantifiable benefits of the PEAK will help the DoD make effective and efficient decisions in implementing the PEAK capabilities.

#### **D. RESEARCH METHOD AND ASSUMPTIONS**

To achieve the purpose set out in Section A, the thesis

- Develops an analytical structure for performing BCA.
- Conducts a BCA for the PEAK based on this structure including:
  - Develops Life-Cycle Cost Estimates (LCCEs) for the PEAK and the status quo;
  - Develops savings in a base case scenario, from a comparison of the PEAK and the status quo;
  - Computes the ROI in a base case scenario;
  - Develops sensitivity analysis of ROI and important programmatic variables.

The comprehensiveness of the BCA is limited by the data and information made available to the author. Key assumptions in this analysis are:

- A conservative approach was adopted. Whenever a choice is to be made between higher and lower costs due to ambiguity in the data, the higher cost is used. Sensitivity analysis is used to test the robustness of the assumption.
- Where information is not available, or is not made available, a "worst case" assumption is made.
- The Joint Inflation Calculator (Naval Center for Cost Analysis, 2012) is used to adjust all dollar amounts to FY12 dollars.

## **E. REVIEW OF LITERATURE**

We begin the study with a review of literature in Chapter II. Chapter III develops the background of the key technologies currently employed for HA/DR response by all of the Services. Chapter IV forms the model and develops the BCA of procuring and deploying the PEAK system with comparison to the status quo system. Chapter V formulates conclusions and recommendations.

## **II. REVIEW OF LITERATURE**

The purpose of this study is to analyze the costs and benefits of implementing the PEAK as a new capability into the HA/DR operational community with the objective of building key capacity in partner nations to promote security and stability, and focus on providing effective, low-cost, and sustainable capabilities. The literature listed below addresses the objectives of HA/DR and discusses the operational, planning, and legal framework of military support for HA/DR.

Concepts for the employment of military forces have expanded beyond the traditional paradigm of wartime operations. Military operations now include Stability Operations, which are becoming a more prevalent aspect of military operations. The Chairman of the Joint Chief of Staff defines "Stability Operations" as various missions, tasks, and activities conducted outside the U.S., in coordination with other instruments of power, to maintain or reestablish a safe and secure environment and to provide essential government services, emergency infrastructure reconstruction, and humanitarian relief (Office of the Chairman of the Joint Chiefs of Staff, 2011).

Joint Publication 3–07, "Stability Operations," provides doctrine for the conduct of stability operations during joint operations within the broader context of U.S. Government efforts. It provides guidance for operating across the range of military operations to support U.S. Government agencies, foreign governments, intergovernmental organizations, and activities until it is feasible to transfer lead responsibility (Office of the Chairman of the Joint Chiefs of Staff, 2011). HA/DR is one of the five military functions of Stability Operations. The others are security, economic stabilization and infrastructure, rule of law, and governance and participation.

National Maritime Strategy, "A Cooperative Strategy for 21<sup>st</sup> Century Seapower," identifies an approach that integrates seapower with other elements of national power, as well as national power of our friends and allies. It notes that



preventing wars is as important as winning wars. The strategy demonstrates the importance of asserting the DoD national power through contingency operations. The strategy provides guidance for strengthening international and regional security. As a global power, the United States' interests are intertwined with the security and stability of the broader international partnerships. HA/DR activities employ joint forces to address partner needs and sometimes provide opportunities to build confidence and trust between past adversaries. HA/DR activities help the U.S. government gain access and relationships that support U.S. national interests (Chairman of the Joint Chiefs of Staff, 2011).

The Quadrennial Defense Review (QDR) Report provides guidance for building the security capacity of partner states. Since the United States assumed the role as the global security provider after World War II, DoD has worked actively to build the defense capacity of allied and partner states. This has given the U.S. military opportunities to train with and learn from their counterparts, and to further the U.S. objective of securing a peaceful and cooperative international order. In order to ensure that improvements in partner security forces are sustained, seeking to enhance the capabilities and capacity of security institutions that support fielded forces is essential (Secretary of Defense, 2010).

A source for disaster data is the Federal Emergency Management Agency (FEMA). FEMA defines a disaster as an event which results in a minimum of 100 deaths/injuries, or results in over \$1 million worth of damage. In other words, there must be some form of substantial damage or high impact in order for relief efforts to be granted (Federal Emergency Management Agency, 2010). Another source of data is the International Disaster Database, known as Emergency Events Database (EM-DAT). The EM-DAT website, run by the Centre for Research on the Epidemiology of Disasters (CRED), undertakes research and provides an evidence base on the burden of disease and health issues arising from disasters and conflicts to improve needs-based preparedness and responses to humanitarian emergencies (Emergency Events Database, 2011).

The book, “Humanitarian Logistics: A New Field of Research and Action,” provides the disaster classifications, which includes the nature of the location of the disaster (localized or dispersed), as well as the onset rate (fast or slow). The disaster classifications provide a useful structure for classifying disasters in considering the difficulties that may be associated with aid response. Localized disasters that occur slowly provide responders with more time to prepare and spread resources across a smaller area, which makes responding to these types of disasters much easier than responding to dispersed disasters that occur suddenly (Apte, 2009).

Department of Defense Instruction 5000.02 directs the development of Business Case Analyses (BCA), especially for new systems. The BCA assesses each alternative and weighs total time-phased, discounted costs against total benefits to arrive at the preferred solution (Defense Acquisition University, 2007). Similar studies examining the cost and benefits of new technology have been completed in the past, including the following four Naval Postgraduate School (NPS) theses:

- The Cost Benefit Analysis of the Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) is a comprehensive analysis of the costs and benefits of an Energy Surety Microgrid (ESM) facility to the Navy (Leewright, 2012).
- The Impact Of Rechargeable Batteries: Quantifying The Cost And Weight For A Marine Infantry Battalion examines the viability, cost savings, and operational weight associated with the use of rechargeable batteries in USMC Infantry battalions (Brown, 2011).
- Cost Benefit Analysis of a Utility Scale Waste-to-Energy/ Concentrating Solar Power Hybrid Facility at Fort Bliss is a comprehensive analysis of the costs and benefits of a waste to energy facility to the Army (Clement, 2012).
- A Business Case Analysis of a Medium Altitude Global ISR Communication (MAGIC) UAV System (Kolar, 2012).

The PEAK JCTD Management Plan describes the management approach for executing the PEAK JCTD. It provides guidance for the PEAK team and serves as an agreement among the signatory parties (Office of the Secretary of Defense (OSD), 2010a).

The sources above underscore the importance of today's U.S. military operations taking a leading role in disaster response efforts throughout the globe. Stability Operations are a core U.S. military mission, which is critical in keeping our alliances and in preventing war.

### **III. BACKGROUND**

This chapter addresses the key technologies currently employed for HA/DR response by all of the Services. In order to form a meaningful understanding of the field of HA/DR, it is first necessary to understand the current technologies used in the field. A summary of the status quo, Joint Capability Technology Demonstration (JCTD) program, and the PEAK is provided. The chapter concludes with an overview of this study's BCA methodology.

#### **A. STATUS QUO**

Four existing components of providing essential and sustainable services during HA/DR responses are (1) Lightweight Water Purifier, (2) Power Generator, (3) New Energy System Technologies (NEST) Raptor Solar Light Trailer, and (4) Hastily Formed Network (HFN). These services are described below.

##### **1. Lightweight Water Purifier**

The Lightweight Water Purifier (LWP) provides water purification and storage to small units during HA/DR operations. It produces potable water from freshwater, brackish water, and saltwater sources. The characteristics are (Balling, 2009):

- Produces 75 gallons per hour on seawater (45,000 ppm) and 125 gallons per hour on freshwater
- Generates treatment by settling, ultrafiltration, and reverse osmosis
- Is man-portable and modular
- Is transportable in High-Mobility Multipurpose Wheeled Vehicle (HMMWV) and medium tactical helicopter
- Is air-droppable

The LWP is shown in Figure 3.



Figure 3. Light Water Purifier (from Balling, 2009)

## 2. Power Generator Set

The 2KW Military Tactical Generator Set, MEP-531A, is a self-contained, skid mounted, and portable unit. It is equipped with controls, instruments and accessories necessary for operation (Marine Corps Systems Command, 2008). The MEP-531A consists of a diesel engine, direct drive AC alternator, speed governing system, fuel system, 24VDC auxiliary cold weather starting system (23°F or below), and generator control system. The MEP-531A can be used with any equipment requiring a small source of Alternating Current (AC) power. It is shown in Figure 4.

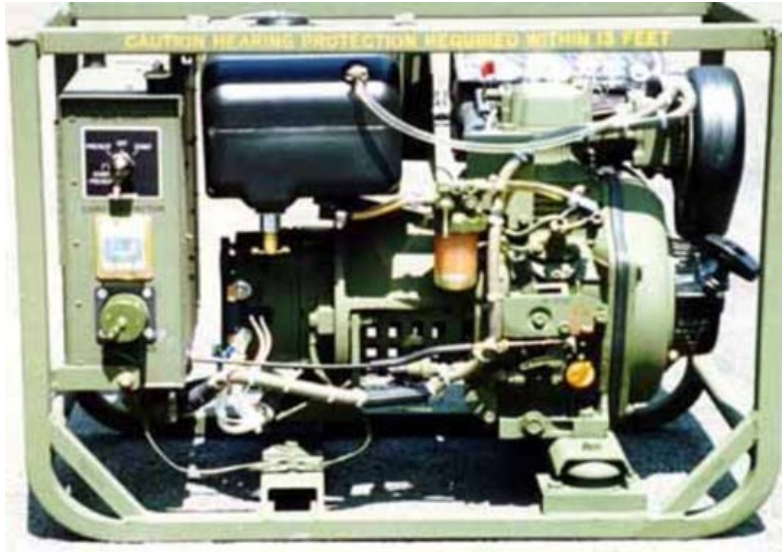


Figure 4. Generator Set MEP-531A (from United States Marine Corps Systems Command, 2009)

### 3. New Energy System Technologies Raptor Solar Light Trailer

The New Energy System Technologies (NEST) Raptor Solar Light Trailer, shown in Figure 5, is a remote lighting capability that does not require external power. It consists of four 10-foot-by-10-foot solar panels, rated at 175 watts per piece, a solar controller, and eight lead acid batteries.



Figure 5. The NEST Raptor Solar Light Trailer (from NEST Energy Systems, 2011)

#### **4. Hastily Formed Network**

Hastily Formed Network (HFN)'s mission is to support the United States government and military by bringing satellite-enabled rapid wireless communications to the most critical areas and functions, working with Joint Task Forces. The first priority after the disaster event is for the responders to communicate. The ability to form multi-organizational networks rapidly is crucial to humanitarian aid, disaster relief, and large urgent projects. The responders want to pool the knowledge and interpretations of the situation, understand what resources are available, plan responses, and coordinate. Without emergency communications, the responders cannot coordinate and operate (Denning, 2006).

A HFN is a rapid response wireless communications system from military, civilian government, and non-government organizations. The tasks performed by HFN participants are:

- Set up mobile communication and sensor systems
- Conduct interagency operations
- Collaborate on action plans and coordinate the response team's execution
- Lead a social network where communication and decision-making are decentralized and there is no hierarchical chain of command

HFN equipment includes:

- Four Broadband Global Area Network satellite units which connect to the Internet via the International Maritime Satellite Network in five minutes and generate 100-meter wireless clouds
- Four foldable 10-foot-by-10-foot solar panel tarps that generate 800 watts of power from sunlight or a wind turbine (same solar panel tarps used in NEST Raptor Solar Light Trailer)
- Global Positioning System (GPS) devices and visualization systems which provide situational awareness in a command-center-like configuration

The benefit of using emergency communications is the quicker response to emergency medical situations. For example, during the Haiti Earthquake HA/DR response, the Naval Postgraduate School's HFN team used the emergency communications system to arrange a medivac of an injured child. The child suffered a life-threatening femur fracture where an infection set in. The child was medivaced to the United States Ship Comfort, a floating hospital ship, where he was properly treated. His life was saved; other lives were saved during the HA/DR response. (Hastily Formed Network, 2010)

The cost of the four components of the status quo listed above is less than the cost of the PEAK, mainly because the ISU 60 container trailer is not included. The disadvantage of the status quo is the separate arrivals of components for operations; this is because the components are not integrated into one system. The problem arises because the HFN could arrive later than the LWP or power generators, which would create the delay of emergency communication.

## **B. JOINT CAPABILITY TECHNOLOGY DEMONSTRATION**

The Joint Capability Technology Demonstration (JCTD) program evolved from the Advanced Concept Technology Demonstration (ACTD) Program, which had its inception in 1994 under the sponsorship of the DoD. The program is led by the Deputy Under Secretary of Defense (Advanced Technology) (DUSD(AT)), who works with a team of ACTD/JCTD oversight executives to interact with the various AT divisions to harvest capabilities for COCOMs. In 2006, the JCTD program was initiated to update the successful ACTD program to meet the DoD's transformational goal of becoming capability-based, rather than threat-based, in its focus. The JCTD program includes many of the positive aspects of the ACTD program, as well as improvements to meet new and evolving defense challenges. The process integrates the ACTD program with the new Joint Integration and Development System (JCIDS) developed by the Joint Chiefs of Staff (JCS). The JCTD process focuses on joint and transformational



technologies that are initiated in Science and Technology (S&T) and carried through the difficult transition stage (Seng, 2008).

The mission of the JCTD program is to find, demonstrate, transition, and transfer the best operational concepts and technology solutions for transformational, joint, and coalition warfare. The JCTD program directly addresses Joint, Coalition, and Interagency capability needs expressed by the COCOMs. Based on significant successes since inception of the program, the COCOMs now view the JCTD program as a primary means to develop, assess, and transition needed capabilities (Joint Capability Technology Demonstrations, 2011).

The JCTD and Advanced Technology Demonstration (ATD) are used to expedite the transition of maturing technologies from the developers to the users. The JCTD program emphasizes technology assessment and integration rather than technology development. The goal of the JCTD program is to provide a prototype capability to the warfighter and to support him in the evaluation of that capability. Warfighters evaluate the capabilities in military exercises at a scale sufficient to fully assess military utility. The developers allow the warfighter and material developer to jointly experiment with the application of technologies and new operational concepts in a field environment prior to committing to formal acquisition. The JCTD concepts are nominated, approved, and funded by the Joint Staff. The assessment will address the operational effectiveness and operational suitability of the proposed solution. The sponsor will develop the appropriate Joint Capabilities Integration and Development System (JCIDS) proposal if the concept is to transition to an acquisition program. (Department of the Army, 2009).

The JCTD program offers three possible post demonstrations transition models as described below (Seng, 2008).

- Transition to Program of Record (POR). The military utility of the program has been successfully demonstrated, and the concepts will be adopted by the warfighters. Products will be transferred to a

new/current POR or Government Services Administration schedule. The acquisition of additional capability will also be funded.

- Interim Capability to Meet Needs of the Warfighter. Same as above. However, the products may or may not have been sent to a POR. This interim capability fully meets the warfighter's needs and is being maintained.
- Return to Technology Base. The military utility is deemed to be not successfully demonstrated. Relevant components or capabilities may be incorporated into other systems, returned to the technology base, or terminated.

### **C. PRE-POSITIONED EXPEDITIONARY ASSISTANCE KIT**

In March 2010, the OSD, USSOUTHCOM, and the National Defense University selected the Pre-Positioned Expeditionary Assistance Kit (PEAK) as a JCTD candidate to address the current operational gap for capabilities that can be pre-positioned to help provide sustainable and essential services in time sensitive events (Office of the Secretary of Defense (OSD), 2010a). The PEAK aims to lower logistics costs, as well as to provide responsiveness during a crisis event.

The PEAK is designed to be forward staged and deployable to a disaster response area within 12 hours of a disaster event. It provides immediate vital services in the first 72 hours to disaster response teams. The operators of the PEAK equipment are U.S. military and government personnel, as well as foreign military and government personnel with U.S. assistance, as required. The primary recipients of the PEAK services are the PEAK operators, the local populace, and local first responders.

Components of the PEAK are shown in Figure 6 (Office of the Secretary of Defense (OSD), 2010b) and described below.

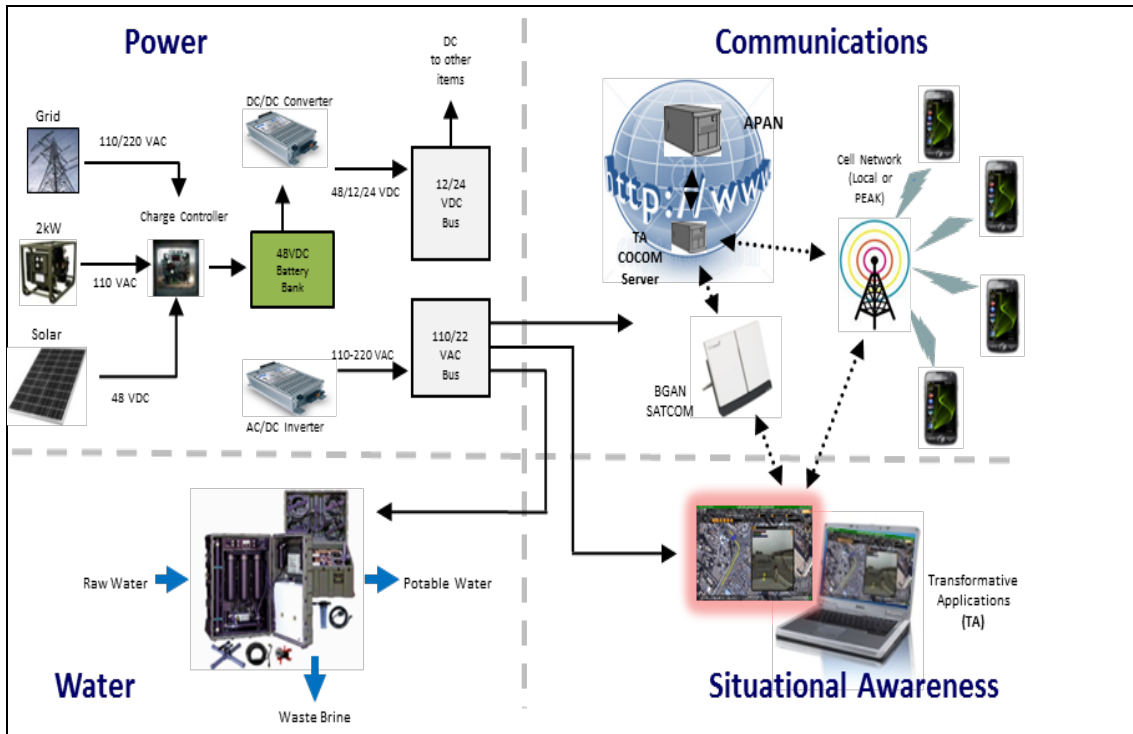


Figure 6. PEAK Elements (from Office of the Secretary of Defense (OSD), 2010b)

USSOUTHCOM has identified four primary desired capabilities for the PEAK. These desired capabilities focus on providing essential services early in a crisis, while building interagency and joint cooperation with partner nations (National Defense University, 2010). Top-level PEAK capabilities are described below. Detailed high-level PEAK capabilities and specifications are provided in Appendix A.

- Water purification to produce potable water from fresh, brackish, or salt water
- Reliable power from primarily renewable sources for the PEAK
- Situational awareness and information sharing on threats, local populace, services, environment, infrastructure, and other support personnel to enable first responders and decision makers to respond effectively to a time-sensitive event

- Regional and international communication to transmit and receive voice, data, and images

The top-level specifications of each PEAK system are listed in Table 1.

<b>Services</b>	<b>Specification</b>
Potable water	Desalination 1800 gal/day (approximately 800 people)
Power	Hybrid Power 2.2 KW Solar, 2 KW Diesel Generator, 38KWH Battery Storage
Situational Awareness	Handheld device (i.e., smart phone) with applications for template/survey input (Internet, SMS, cell phone network), imagery/video attachment, walking maps, GPS, and voice recording
Communications	Portable Cell Network (2NM radius, 20 users), SATCOM (Narrow band connection to web)

Table 1. Top-level Specifications of the PEAK System (from National Defense University, 2011)

#### **D. BUSINESS CASE ANALYSIS**

A Business Case Analysis (BCA) is a basic financial tool used by decision makers to evaluate alternative approaches and to decide on the best courses of action, with due regard for allocation of scarce resources. The BCA is a structured, systematic method, which provides a best value analysis that considers time-phased costs and other factors that are relevant to the investment decision (Defense Acquisition University, 2007).

The decision to pursue a BCA is directed by policy in DoD Instruction 5000.02. The BCA assesses each alternative and weighs total time-phased, discounted costs against total benefits to arrive at the preferred solution. A BCA should include:

- An introduction
- The objectives of the case
- The methods, assumptions, and constraints
- The status quo

- An alternative
- The costs and benefits of an alternative
- Sensitivity analysis
- Conclusions

A generic BCA methodology can be described as a four-phase process, as shown in Figure 7 (Defense Acquisition University, 2007).

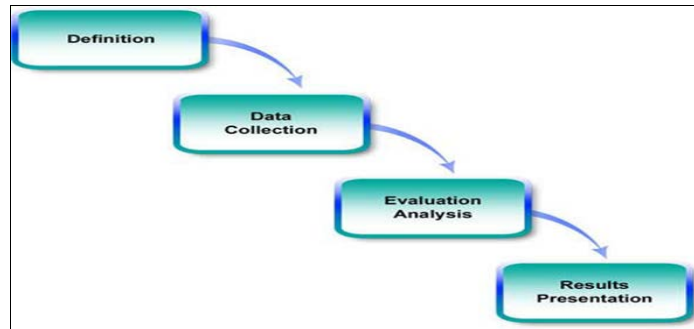


Figure 7. Business Case Analysis Methodology (from Defense Acquisition University, 2007)

The phases in the process are listed and described below.

### **1. Definition**

The first phase in the BCA process, the scope, assumptions and constraints, will guide the analysis. This phase also identifies the alternatives the BCA will consider.

### **2. Data Collection**

In the second phase, a data collection plan is devised so that the types of data required, data sources, and how they can be obtained can be mapped out. Models must also be developed so that the data can be categorized and stored while preserving its integrity. Data normalization is also applied where required. Where the data is not available, estimates can be made, as long as they can be justified, and the methodology adopted is explained clearly.

### **3. Evaluation Analysis**

In the third phase, Cost models are developed, parameters are calculated, and results are assessed. Data analysis is performed to build the case for each alternative using the data collected in phase two. Results of alternatives are compared to determine the alternative that provides the best cost-benefit combination. Sensitivity analysis is performed to provide insights as to how changes in key input parameters, underlying assumptions that were made, and constraints influence the outcome of the analysis.

### **4. Results Presentation**

In the fourth phase, results are summarized, and presented in graphs and tables, and delivered to the decision-maker. The information presented should be concise, with relevant supporting evidence from the previous phases. A conclusion is also provided to the decision-maker based on the objectives defined in the first phase.

For this study, we produce a BCA in accordance with the BCA methodology above. We assess the Life-Cycle Cost (LCC) of the status quo and then assess the LCC of the PEAK to determine the alternative that provides the best cost-benefit combination. We perform the sensitivity analysis to provide insights as to how changes in key input parameters, and constraints influence the outcome of the analysis. We summarize and present the results in the graphs and tables. Finally, we recommend the best alternative to the decision-maker based on the outcome from the comparison of the LCC assessment.

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## **IV. PEAK BUSINESS CASE ANALYSIS**

This chapter develops the BCA of procuring and deploying the PEAK system, and compares it with the cost of the status quo systems. The analysis starts by developing a scenario of an earthquake in Latin America and the Caribbean region. Within the context of this scenario, we compute and compare net savings, Net Present Value (NPV), and Return on Investment (ROI), as well as a sensitivity analysis on the key results obtained.

### **A. RESEARCH QUESTIONS**

The primary objective of this thesis is to analyze the cost savings and the benefits of implementing the PEAK capability. In addition, this thesis answers the following secondary questions.

- What are the cost differences in Research and Development (R&D), Investment, and Operations and Support (O&S), between the status quo and the PEAK?
- What are other quantified benefits, such as water and transportation savings, of using the PEAK?
- Will the PEAK provide benefits in support of United States operations and promote security and stability in the theater?

These questions are answered in section D in this chapter.

### **B. METHODOLOGY**

We evaluate the financial attractiveness of the PEAK by:

- calculating LCC of the status quo and the PEAK
- comparing LCC of the status quo and the PEAK
- calculating NPV and ROI over a 10-year, base-case scenario for a fixed period time. We choose ten years because major weapons systems use a 20-year scenario, and since the PEAK is not a major



weapons system, we expect an enhanced result by analyzing a 10-year scenario.

- evaluating the robustness of the answers obtained above with sensitivity analysis of the important input variables

In particular, the NPV and ROI analyses consider the expected savings that the PEAK enables, compared with the status quo. Savings are assessed from the integrated capabilities that the PEAK has (i.e., water, transportation, HFN). Interestingly, the savings actually come from the costs of water and transportation. Water savings occur because the PEAK replaces the water costs that would normally occur under the status quo, during an initial period of a disaster. Transportation savings occur because once a PEAK system is in theater, there are no additional costs to move it within theater.

These ideas, as well as the scenario in which our analyses will take place, will be explained in section D, paragraphs 3 and 4 of this chapter.

### **C. SAVINGS OF THE PEAK COST ELEMENTS**

The cost of using HA/DR expeditionary assistance kits depends on their operational use. This thesis develops the cost estimates of using the PEAK in an operational scenario. The results from these analyses should not be considered definitive, but rather useful for comparing the costs and benefits of the status quo and the PEAK. The results may aid decision makers in their evaluation of short-term and long-term effects of employing the status quo versus the PEAK.

PEAK enables savings in two areas:

- Costs of water as part of the disaster relief effort
- Transportation of the PEAK into the disaster area

For each of these areas, we develop estimates of the savings from using the PEAK, compared to the status quo, as a function of the type and number of disasters. We begin with a taxonomy for disasters, as developed by Apte in "Humanitarian Logistics" (Apte, 2009). Apte defines a disaster as a natural or man-made hazard resulting in an event of substantial extent causing significant

physical damage or destruction, loss of life, or drastic change to the environment. Disaster events include earthquakes, floods, catastrophic accidents, fires, or explosions that can cause damage to life and property, and destroy the economic, social and cultural life of people (Federal Emergency Management Agency, 2010).

The classification of disasters is based on location (whether it is localized or dispersed) and the arrival time (whether it has slow or sudden onset). Apte includes the nature of the location of the disaster, localized or dispersed, as well as the onset rate, to provide a more useful structure for classifying disasters to help consider the difficulties that may be associated with aid response. Classification moves from slow to sudden onset, and from a localized to a dispersed area, as the difficulty of the response increases. This classification scheme provides a useful structure for classifying disasters (Apte, 2009) and is displayed in Figure 8.

The level of difficulty for the relief effort is greater when disasters are dispersed. The reason for this is that effectiveness and efficiency of transportation and distribution of critical supplies and services suffer. The large and scattered geographical area takes a substantial amount of cost and coordination among responders. In addition, the level of difficulty for the relief effort is greater if disasters have sudden-onset of arrival time due to challenging problems for response since no organization can prepare well for such an event (Apte, 2009).

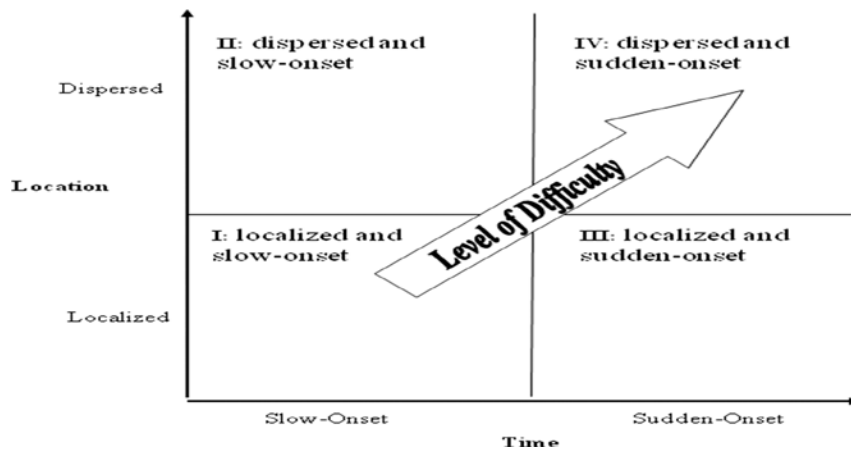


Figure 8. Classification of Disasters (from Apte, 2009)

For the analyses, we leverage this taxonomy to create "large" and "small" disasters or, as we call them, "standard" and "non-standard" disasters. They are defined by:

- Standard Disaster—quadrants I, II, and III, or response cost under \$25M
- Non-standard Disaster—quadrant IV, or response cost greater than \$25M

#### D. PEAK SCENARIO

USSOUTHCOM is the area of interest for deployment of the PEAK systems to help provide sustainable and essential services in time-sensitive events. USSOUTHCOM provides the tasking requirements for the operational scenario in Latin America and the Caribbean region in support of its HA/DR mission.

We use the base case scenario of positioning two PEAK systems with Joint Task Force-Bravo (JTF-B) located at Soto Cano Air Base, Honduras. Upon receipt of the kits, members of JTF-B receive one day of training from members of the USSOUTHCOM headquarters, followed by one day of exercises with trainer support. The day after the training and exercise, an earthquake of magnitude 8.0 strikes a region in Central America outside of Honduras.

USSOUTHCOM tasks JTF-B to deploy within 12 hours to provide disaster relief support to the region for 72 hours until a larger force provides additional relief. JTF-B deploys one PEAK and six operators via air and land transport to the affected region no later than 12 hours following receipt of the deployment order. Once JTF-B employs the PEAK, they provide situational awareness of the affected region to coordinate and facilitate the disaster relief efforts. Additionally, JTF-B provides fresh water to the affected population and to disaster relief personnel. JTF-B returns to Soto Cano Air Base within 72 hours after employment of the PEAK. The PEAK returns to Soto Cano Air Base with JTF-B.

The key assumptions of the base case are the following:

- The PEAK operates or is employed for 72 hours until USAID or other agency begins its operations
- USSOUTHCOM invests in one PEAK for the operations
- 13 standard and 2 non-standard disasters occur in a one- year period in USSOUTHCOM AOR. These numbers are extrapolated from the data below:
  - There were 55 standard and 7 non-standard worldwide disasters in 2009 (See Appendix B)
  - There were 68 standard and 5 non-standard worldwide disasters in 2010 (See Appendix C)
  - Average of 2009 & 2010 disasters - 62 standard and 6 non-standard disasters
  - One-fourth of the average disasters (13 standard and 2 non-standard disasters) is derived from the fact that the 2009/2010 data is compiled from four regions in the world and the PEAK scenario is based on a single region, USSOUTHCOM AOR
- The actual data of the length of standard-disasters is not available. Therefore, we use an arbitrary number of 25 days as the length for a standard disaster relief.

## **E. DATA ANALYSIS**

The following sections develop and compare LCCE for the status quo and the PEAK. Data sources of the LCCE are required to get the correct comparison of estimates between two systems. The following data sources provided information to support the development of the LCCEs.

- The PEAK Management and Implementation Plan (National Defense University, 2010)
- The PEAK demonstration plan (United States Southern Command, 2010a)
- Telephone interviews with the PEAK program manager, Russell Horn from Naval Sea Systems Command
- Disaster response cost statistics from the USAID annual report in 2010 (United States Agency for International Development, 2010)
- Japan Earthquake Relief Cost Report (Office of Assistant Secretary of Navy Financial Management and Comptroller, 2011). The data was collected from the PEAK Management and Implementation Plan (National Defense University, 2010)

### **1. Life-Cycle Cost Estimates**

The Defense Acquisition University (DAU) defines Life-Cycle Cost Estimates (LCCE) as the total cost to the government for a system over the lifetime of a defense acquisition program (Defense Acquisition University, 2008a). A Work Breakdown Structure (WBS) is the structure that encompasses an entire program at a summary level. It defines and groups a project's discrete work elements in a way that helps organize and define the total work scope of the project. A WBS provides the necessary framework for detailed cost estimating along with providing guidance for schedule development and control. In general, to estimate the life-cycle costs of a system, the following WBS is used.

- Research and Development (R&D)–cost of all research and development from initiation through the production decision
- Investment (aka Procurement–total cost of procuring the system and related support equipment
- Operations and Support (O&S)–cost of operating and supporting the fielded system (personnel, training, and maintenance)
- Disposal–costs associated with demilitarization and disposal of a military system at the end of its useful life

In this study, we follow the general life-cycle WBS above cost noted. However, disposal costs of the status quo and the PEAK are negligible, and therefore are not included in the WBS. Table 2 summarizes the cost of one set of status quo equipment with the cost estimate of one PEAK.

<b>WBS</b>	<b>WBS Breakdown</b>	<b>Status Quo (\$K)</b>	<b>PEAK (\$K)</b>
<b>Research &amp; Development</b>		0	380.0
<b>Investment</b>	Light Water Purifier (800 gpd) Generator, MEP-531A (2kW) M116 trailer NEST Solar trailer Hastily Formed Network (HFN) PEAK kit procurement (1)	111.8 5.3 3.1 80.0 9.5	552.5
<b>Operation &amp; Support</b>	Petroleum, Oil, Lubricants (POL) Maintenance Personnel Training	0.6 0 445.2 0	0.6 0 445.2 0
<b>Total</b>		<b>655.5</b>	<b>1,378.3</b>

Table 2. Comparison of the Status Quo and the PEAK over a Period of One Year (FY12\$K)

The bases for these estimates come from Appendix F, which contains the 2010 PEAK spend plan with the purchase of two PEAKs in 2011 (Office of the

Secretary of Defense, 2010a). This PEAK spend plan describes the PEAK kit deliverables in three spirals. The first spiral includes six prototype water desalination and power generation kits to USSOUTHCOM, USPACOM, USAFRICOM in September 2010. The second spiral includes a selection of technical solutions that address water filtration power generation, communications and situational awareness and capabilities in December 2010. The third spiral includes two complete and integrated kits that satisfy the four component capabilities in August 2011.

- PEAK R&D estimate is from the 2010 PEAK Spend Plan (See Appendix F). It includes project management, technical support, knowledge repository, contracting and related costs, analysis of alternatives, and kit design costs for FY 11 and FY 12 only (FY 10 cost is not included because it is a sunk cost). The LCCE for R&D is \$380K.
- Status Quo Light Water Purifier (LWP) estimate per unit is from the End Item Procurement (EIP) and Average Unit Cost (AUC) for Enhanced Reverse Osmosis Water Purification Unit (Marine Corps Systems Command, 2003)
- Status Quo Generator, MEP-531A estimate is from Bidlink.net, NSN 6115-01-435-1565
- Status Quo M116 trailer estimate is from Bidlink.net, NSN 2330-01-101-8434. This is not the ISU 60 trailer which is only included in the PEAK.
- Status Quo NEST Energy Systems Solar Trailer estimate is from the NPS HFN team estimate report, 2012
- Status Quo HFN equipment estimate is from the NPS HFN Haiti expense report
- PEAK kit estimate is from the 2010 PEAK Spend Plan (See Appendix F). The estimate is based on kit procurement of the third spiral, which includes two complete and integrated kits that satisfy

the four component capabilities in August 2011. The cost of one PEAK is \$552.5K (See Appendix F).

- POL estimate is based on \$1.03 per gallon and a consumption rate of 0.33 gallons per hour for 72 operational hours per disaster (Marine Corps Systems Command, 2009).
- Yearly personnel cost (E-5 is assumed) is \$74,207 from DoD military composite standard pay and reimbursement rates (Office of Under Secretary of Navy Comptroller, 2010). The number of operators is six per PEAK management plan, 2010
- Training cost is zero dollars due to the assumption that no operator travel is required, and initial training cost is already covered in personnel cost

While the annual O&S costs for the status quo and the PEAK are the same, it is important to note that the PEAK permits other benefits and savings to accrue to the DoD. These are listed below and discussed in the subsequent paragraphs.

- Quantifiable benefits – water savings, transportation savings
- Non-quantifiable benefits
  - Support HA/DR operations
  - Promote security and stability in theater

## **2. Water Savings**

In this section, water savings is estimated from using the PEAK compared to the status quo. By design, and as described in paragraph C in Chapter III, the PEAK provides potable water for the first three days (72 hours) of a disaster. Under the status quo scenario, there is no water generated during the first three days of an HA/DR operation because water generating/purification equipment could not be brought into the theater during the first three days. The PEAK, on the other hand, begins purifying water on day one. The PEAK, then, is considered a benefit. We assume for this BCA that this benefit is a "savings" and



that the value of the savings is the cost of generating/purifying water under the status quo for three days.

Water costs in the status quo are taken from the compilation of disaster response cost statistics for Water, Sanitation, and Hygiene (WASH) obtained from the Office of U.S. Foreign Disasters Assistance (OFDA) funding summary of FY 2010 (United States Agency for International Development Annual Reports, 2010). The OFDA is an organizational unit within the USAID that is charged by the President of the United States with directing and coordinating international U.S. government disaster assistance. The OFDA maintains expenditure data for all HA/DA crisis that the U.S. government participates in. The OFDA publishes a summary of these expenses in HA/DA crisis events. The OFDA funding summaries for FY 2009 and FY 2010 are listed in Appendices B and C, respectively. For standard and non-standard disasters, we estimate the total savings in water costs that result from using the PEAK by using the average of the 13 standard and 2 non-standard disasters from the OFDA data set. The assumption of using 13 standard and 2 non-standard disasters is described in section D.

**a. *Standard Disasters***

OFDA funding data is used for our analyses. Figure 9 below shows the OFDA funding percentages by sector. The sectors are:

- disaster response programs to support agriculture and food security
- economic recovery and market systems
- health, nutrition, protection, shelter and settlements, and WASH interventions
- humanitarian coordination and information management programs
- search and rescue efforts
- logistical support and emergency relief commodities
- natural and technological risks
- other

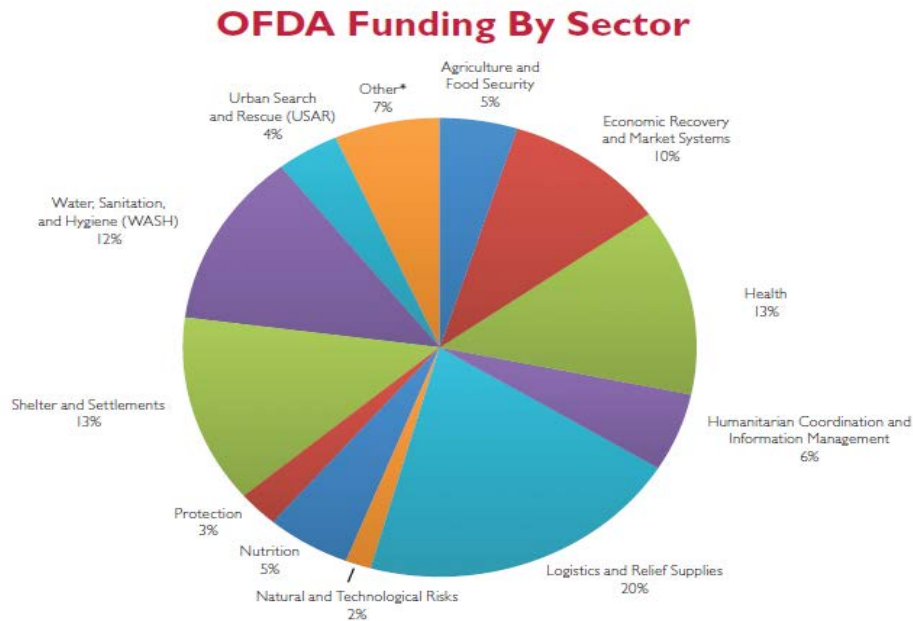


Figure 9. OFDA Funding By Sector (from United States Agency for International Development Annual Reports, 2010)

Figure 9 indicates that 12% of relief expenses incurred during FY 2010 for all disaster responses were attributed to WASH. We assume that these expenditures are made uniformly during the disasters. The 12% figure is used to estimate the cost of water during the first three days of a standard disaster. This cost is the water savings.

To estimate the cost of water, we first extract the data from the OFDA Funding Summary (FY 2010) provided in Appendix C. The total disaster response expenditure is \$656.7M. This included a "prior year disaster cost" of \$1.9M, which is removed to determine current cost of \$654.8M. We then remove the expenses of the five non-standard disasters; the non-standard disasters are Pakistan's floods, Haiti's earthquakes, Sudan's complex emergency, Iraq's complex emergency, and Democratic Republic of Congo's (DRC's) complex emergency. The result for removing these is a total expenditure of \$143.4M on standard disasters. Applying the 12% to this number yields an estimated cost of

water for all 63 standard disasters in FY10 to be \$17.2M. The cost of water per standard disaster would then be  $\$17.2\text{M}/63 = \$273.1\text{K}$ .

Because we assume that expenses are consumed uniformly, and that the average length of a standard disaster is 25 days, the estimate of three days' worth of water consumption is  $\$273.1\text{K} * 3 / 25 = \$32.8\text{K}$  in Fiscal Year 2010 dollars (\$FY10). Using a 2% discount rate we convert this number to \$FY12. Thus, the estimated water savings by using the PEAK system is \$33.7K per standard disaster.

***b. Non-standard Disasters***

The variations between standard and non-standard disasters are too large to use the same cost factor to estimate the water savings. Therefore, we derive a different cost factor from a recent non-standard disaster expense report. Appendix D, from the Office of the Assistant Secretary of Defense (Financial Management & Comptroller) Japan Relief Summary of 2011 disaster, shows that the water cost of the first three days (\$78,400 in \$FY12) is 0.002947% of the total response costs of \$2,660,739,200. This expenditure assumption is made uniformly during the non-standard disasters, and 0.002947% is used as a cost factor to estimate the cost of water in the first three days of a non-standard disaster. Office of U.S. Foreign Disaster Assistance Funding Summary (FY 2010) provides expenditure data for the five non-standard disasters in FY 2010 (United States Agency for International Development Annual Reports, 2010). In each case, the water expenditures are estimated as 0.002947% of the total expenditures. The results are listed below in Table 3 with the average three-day savings per standard disaster equal to \$3.1K. Table 3 shows the five non-standard disasters from the OFDA Funding Summary for FY 2010 (See Appendix C), and the estimated PEAK water savings per non-standard disaster. The costs are transformed into FY 12 dollars, using inflation rates obtained from the 2010 Naval Center for Cost Analysis (NCCA) inflation calculator.

<b>Location</b>	<b>Description</b>	<b>Total Relief Costs OFDA (adjusted to AY 2012 \$K) (App. C)</b>	<b>Estimated PEAK Water Savings (\$K) (0.002947% OFDA Relief Costs)</b>
Pakistan	Floods	110,115	3.2
Haiti	Earthquakes	286,067	8.4
Sudan	Complex Emg	64,588	1.9
Iraq	Complex Emg	41,240	1.2
DRC	Complex Emg	23,332	0.7
Total		525,342	15.4

Table 3. Water Savings of the PEAK for Non-Standard Disasters (FY12\$K)

The average PEAK Water Savings for these five non-standard disasters is approximately \$3.1K per disaster.

### **3. Transportation Savings**

In this section, we estimate transportation savings from using the PEAK compared to the status quo. The PEAK shipments are not required after the first disaster since it is pre-positioned in the region. This information permits us to estimate the savings that the PEAK provides in each disaster. Therefore, the transportation savings enabled by using the PEAK are the differences in transportation costs incurred during each disaster in the status quo and the PEAK.

Transportation costs are those needed to transport the status quo and the PEAK from a supply depot in CONUS to anywhere in the USSOUTHCOM AOR. Appendix E from DHL Express Contract Rates shows that the shipment rate over 300 pounds for region B is \$3.30 per pound. Honduras and most USSOUTHCOM AOR are listed under the rate for region B in DHL Express Contract Rates. We assume that this shipment rate is used uniformly over the disaster, and we use this \$3.30 per pound as a cost factor to estimate the costs of transportation of prior disasters. The estimated transportation costs are listed in Tables 4 and 5.

<b>PEAK Elements</b>	<b>Weight (lbs)</b>	<b>Rates per lbs (\$)</b>	<b>Transportation Cost (\$K)</b>
Water/Comm Side	1,694	3.30	5.6
Trailer	1,550	3.30	5.1
ISU-30	1,671	3.30	5.5
Power Side	1,591	3.30	5.2
Total	6,506		21.4

Table 4. Transportation Costs of the PEAK (FY12\$K)

<b>Status Quo Elements</b>	<b>Weight (lbs)</b>	<b>Rates per lbs (\$)</b>	<b>Transportation Cost (\$K)</b>
Water/Communication Side	1,694	3.30	5.6
Trailer	1,550	3.30	5.1
Power Side	1,591	3.30	5.3
Total	4,835		16.0

Table 5. Transportation Costs in the Status Quo (FY12\$K)

The one-time cost of transporting a PEAK from CONUS to Soto Cano Base is \$21.4K, while the cost of transporting the Status Quo is \$16.0K per disaster. For the first disaster, PEAK costs \$5.4K more to transport than the Status Quo, because of the cost of transporting the PEAK ISU-30 container. For each subsequent disaster, the transportation cost of the status quo is \$16.0K more than the transportation cost of PEAK, because the PEAK is pre-positioned in the region and we assume shipments are not required after the first disaster. For this study, we did not include the round trip shipping cost of the PEAK between Soto Cano Base to the disaster area because JTF-B would deliver it via military transportation.

#### **4. Total Savings**

In this section, we summarize the total savings of using the PEAK per disaster and annualized savings in the base case.

**a. Standard Disasters**

Expected total annual savings from using the PEAK in standard disasters in a year depends on  $n$ , the number of times the PEAK is used in that year:

$$\begin{aligned} \text{Total Savings} &= (\text{Water Savings} + \text{Transportation Savings}) \\ &= (n * 33.7) + (n * 16.0) - 21.4 \end{aligned}$$

For example, the estimated total savings for a PEAK system used 13 times in standard disasters in a year is  $438.1 + 208.0 - 21.4 = 624.7$  (FY12\$K).

**b. Non-standard Disasters**

Total annual savings from using the PEAK in non-standard disasters in a year depends on  $n$ , the number of times the PEAK is used in that year. Combining the results for water savings and transportation savings from above:

$$\begin{aligned} \text{Total Savings} &= (\text{Water Savings} + \text{Transportation Savings}) \\ &= (n * 3.1) + (n * 16.0) - 21.4 \end{aligned}$$

For example, the total annual savings for a PEAK system used two times in non-standard disasters in a year is  $6.2 + 32.0 - 21.4 = 16.8$  (FY12\$K).

**c. Total Annual Savings**

In this section, we estimate the total annual savings for the PEAK. Total annual savings for the PEAK are:

$$\begin{aligned} \text{Water Savings} &= 33.7S + 3.1N \\ \text{Transportation Savings} &= 16.0 * (S + N) - 21.4 \\ \text{Total Annual Savings} &= 49.7S + 19.1N - 21.4 \end{aligned}$$

where  $S$  = # Standard Disaster,  $N$  = # Non-standard Disaster in a year. Figure 10 shows the estimated total savings of the PEAK base case, which is expected to be 13 standard and 2 non-standard disasters in a single year. Total savings increase as the number of times the PEAK is used increases.

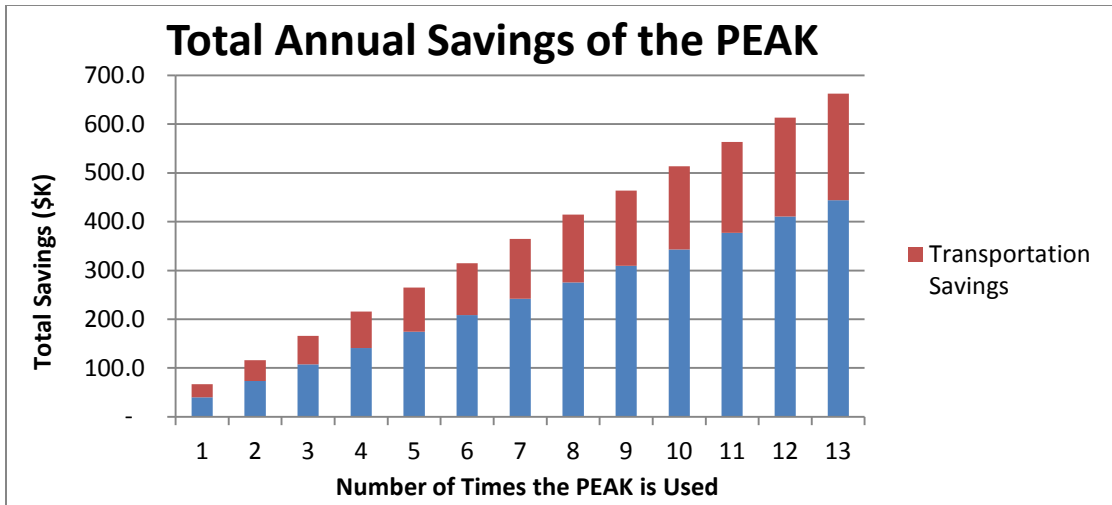


Figure 10. Total Savings of the PEAK Base Case for a Period of One Year (FY12\$K)

Cumulative savings for a period of 10 years are shown in Table 6. The break-even point is defined as the point when the savings equals the investment. A break-even point occurs in a year when:

$$49.7S + 19.1N - 21.4 = \$932.5K \text{ (This investment includes R\&D and procurement cost)}$$

Table 6 shows that a break-even point occurs between the first and second years of using the PEAK.

Year	# Standard Disasters	# Non-standard Disasters	Cumulative Water Savings (\$K)	Cumulative Transportation Savings (\$K)	Cumulative Savings (\$K)
1	13	2	444.3	218.6	662.9
2	26	4	888.6	458.6	1,347.2
3	39	6	1,332.9	698.6	2,031.5
4	52	8	1,777.2	938.6	2,715.8
5	65	10	2,221.5	1,178.6	3,400.1
6	78	12	2,665.8	1,418.6	4,084.4
7	91	14	3,110.1	1,658.6	4,768.7
8	104	16	3,554.4	1,898.6	5,453.0
9	117	18	3,998.7	2,138.6	6,137.3
10	130	20	4,443.0	2,378.6	6,821.6

Table 6 . Cumulative Savings of the PEAK for a Period of 10 Years (FY12\$K)

## 5. Quantifiable Benefit Estimates

Figure 11 shows the cumulative cash flow, which is cumulative savings minus costs, of using the PEAK for a period of 10 years, assuming 13 standard disasters and 2 non-standard disasters per year. The break-even point occurs between years one and two. Total undiscounted quantifiable benefits of total cash flow are:

$$\$6,821.6K - \$932.5K = \$5,889.1K \text{ (FY12\$K)}$$

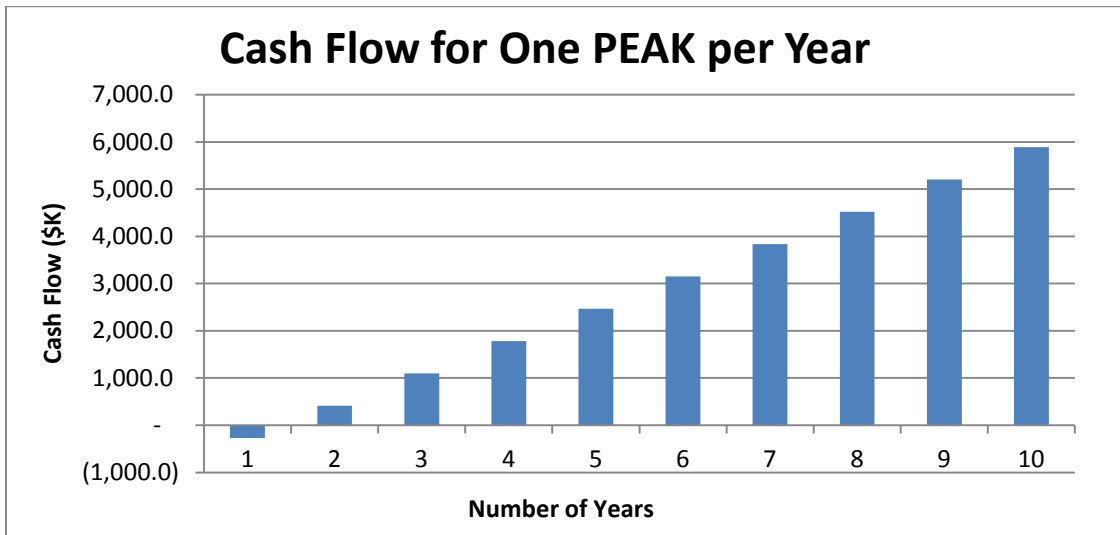


Figure 11. The PEAK Cash Flow for a Period of 10 Years (FY12\$K)

## 6. Net Present Value (NPV) Analysis

In order to estimate Return on Investment (ROI) for the PEAK, we need to perform NPV estimation, which requires a time-phasing of the PEAK costs and benefits. Costs and benefits are adjusted to Present Value (PV) by using discount factors to account for the time value of money. PV is calculated as (Naval Postgraduate School, 2012):

$$PVF = \frac{1}{(1+d)^t}$$

$$PV = PVF * (\text{Cash Flow})$$



where:

$PVF_t$  = the PV factor for the t-th project year

$d$  = the discount rate

$t$  = the project year

For example, the Present Value (PV) discount factor of the third project year at a 2% discount rate is:

$PVF_3 = 1 / (1 + .02)^3 = 0.9423$  (This means that 0.9423 will grow to 1.0000 in three years if compounded at 2%.)

Then Net Present Value, NPV, which is Total PV Savings - Total PV Costs, is calculated as (Naval Postgraduate School, 2012):

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+d)^t}$$

where:

$CF_t$  = Cash Flow for the t-th project year

$d$  = the discount rate

$n$  = the number of years of the system's lifetime

Office of Management and Budget (OMB) Circular A-94 recommends using a 2% discount rate for a 10-year program (Office of Management and Budget, 2012). Table 7 shows the 10-year PEAK NPV using the recommended 2% discount rate. NPV of the PEAK over a period of 10 years is:

$$\begin{aligned} \sum_{t=0}^n \frac{CF_t}{(1+d)^t} = & \frac{\$(662.9-932.5)K}{(1+0.02)^1} + \frac{\$(1,347.2-662.9)K}{(1+0.02)^2} + \frac{\$(2,031.5-1,347.2)K}{(1+0.02)^3} + \\ & \frac{\$(2,715.8-2,031.5)K}{(1+0.02)^4} + \frac{\$(3,400.1-2,715.8)K}{(1+0.02)^5} + \frac{\$(4,084.4-3,400.1)K}{(1+0.02)^6} + \\ & \frac{\$(4,768.7-4,084.4)K}{(1+0.02)^7} + \frac{\$(5,453.0-4,768.7)K}{(1+0.02)^8} + \frac{\$(6,137.3-5,453.0)K}{(1+0.02)^9} + \end{aligned}$$

$$\begin{aligned} \frac{\$(6,821.6-6,137.3)K}{(1+0.02)^{10}} &= \$(264.3)K + \$657.7K + \$644.8K + \$632.2K + \$619.8K \\ &\quad + \$607.6K + \$595.7K + \$584.0K + \$572.6K + \$561.4K \\ &= \$5,211.6K \end{aligned}$$

If NPV is greater than zero, then the project generates sufficient cash flows to repay the invested capital. Therefore, PEAK's positive NPV means that PEAK is an attractive investment under the given assumptions.

	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Annual Cash Flow	(269.6)	684.3	684.3	684.3	684.3	684.3	684.3	684.3	684.3	684.3
PV <sub>t</sub>	(264.3)	657.7	644.8	632.2	619.8	607.6	595.7	584.0	572.6	561.4
NPV <sub>t</sub>	(264.3)	393.4	1,038.2	1,670.4	2,290.2	2,897.9	3,493.6	4,077.6	4,650.2	5,211.6

Table 7. Net Present Value (NPV) of PEAK for a Period of 10 Years and df=2% (FY12\$K)

## 7. Return on Investment Analysis

Return on Investment (ROI) compares the savings expected, over a specified period of time and with the investment. ROI is calculated as follows:

$$ROI = \frac{NPV (Savings)}{NPV (Investment)}$$

For the base case (13 standard and 2 non-standard disasters for 10 years and discount factor =2%)

- NPV (savings) = \$5,211.6K
- NPV (investment) = \$932.5K

$$ROI = \frac{\$5,211.6K}{\$932.5 K} = 559\%$$

ROI is 559%, which is an attractive return. The annual ROIs of the PEAK base case for a 10-year period are shown in Figure 12. All PEAK investment costs were recouped, on an NPV basis, between one and two years.

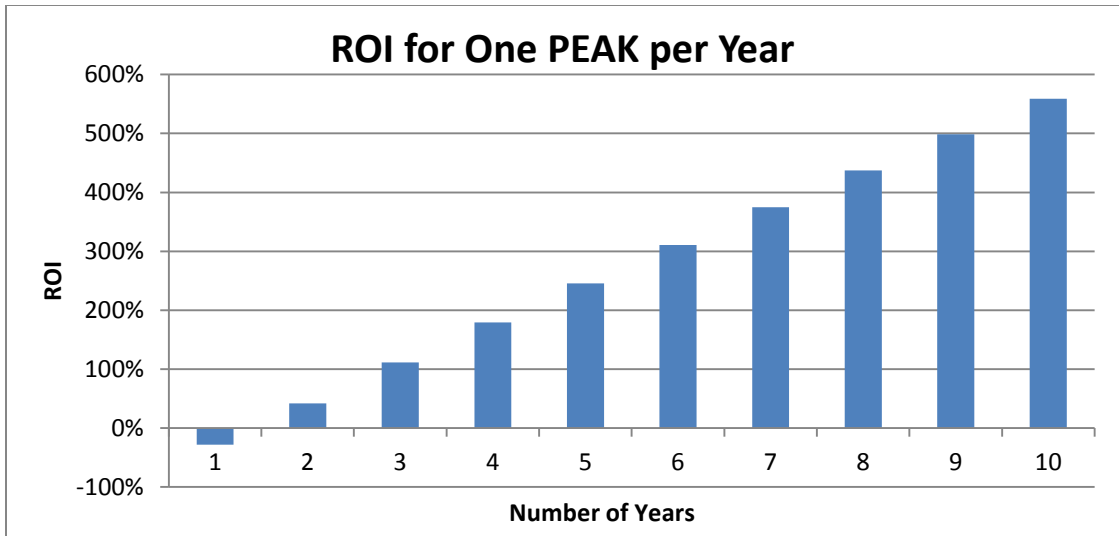


Figure 12. Annual Return on Investment of the PEAK Base Case for a 10-year Period

## 8. Sensitivity Analysis

The purpose of sensitivity analysis is to determine the responsiveness of a model's results to uncertainty in the input data. Therefore, the sensitivity analysis provides decision-makers with insight regarding the robustness of the model's output as a function of varying input parameters. Table 8 displays the factors in the PEAK scenario that are varied for the sensitivity analysis.

Variables	Base Value	Minimum Value	Maximum Value
Number of COCOMs which will have the PEAK(s)	1	1	3
Number of Standard Disasters per Year	13	10	16
Number of Non-standard Disasters per Year	2	1	3
Investment Cost of the PEAK (FY12\$K)	932.5	932.5	2037.5

Table 8. Factors Varied for Sensitivity Analysis

We perform 12 analyses, which include three excursions for each variable, setting each variable at its minimum, maximum, and base values. In each analysis, we change only one variable that was assumed in the base case.

**a. Number of COCOMs which Will Have the PEAK(s)**

The analysis we have completed at this point considers the ROI for one PEAK in one COCOM. It is more realistic to consider multiple COCOMs investing in the PEAK, because this is how the DoD makes investments in technology. Therefore, in this section, we address the issue of whether adding COCOMs changes the PEAK ROI.

In order to accomplish this analysis, we needed to adjust both the investment in the PEAK and the savings that were available by using the PEAK. For each additional COCOM, we use the same scenario as we did in the one COCOM base case. We added investment funding to buy one PEAK per COCOM, and we imputed the same savings, both for water and for transportation, for the added COCOMs used in the base case. We assume the R&D cost of \$380K applies only for the first PEAK in the first COCOM and the cash flow for the added COCOMs are shown in Table 9 .

Yr	Investment/ 1 COCOM	Cash Flow/ 1 COCOM	Investment/ 2 COCOMs	Cash Flow/ 2 COCOMs	Investment/ 3 COCOMs	Cash Flow/ 3 COCOMs
1	932.5	(269.6)	1,485.0	(159.2)	2,037.5	(48.8)
2	-	414.7	-	1,209.4	-	2,004.1
3	-	1,099.0	-	2,578.0	-	4,057.0
4	-	1,783.3	-	3,946.6	-	6,109.9
5	-	2,467.6	-	5,315.2	-	8,162.8
6	-	3,151.9	-	6,683.8	-	10,215.7
7	-	3,836.2	-	8,052.4	-	12,268.6
8	-	4,520.5	-	9,421.0	-	14,321.5
9	-	5,204.8	-	10,789.6	-	16,374.4
10	-	5,889.1	-	12,158.2	-	18,427.3

Table 9. Cumulative Cash Flow of the PEAK for a Period of 10 Years  
(FY12\$K)

We analyze the base case as well as the case for a second COCOM, and further for the case of adding a third COCOM. These results are

presented in Figure 13. ROIs from using the PEAK are greater as the number of COCOMs using the PEAK increases. This is the result of greater cumulative cash flow occurring when the number of COCOMs increases, using the PEAK with same unit investment cost of \$552.5K without R&D cost of \$380K. Figure 13 shows the changes in the ROIs with varying the number of COCOMs with one PEAK for a period of 10 years. The break-even points of all three COCOMs using the PEAK occur between one and two years.

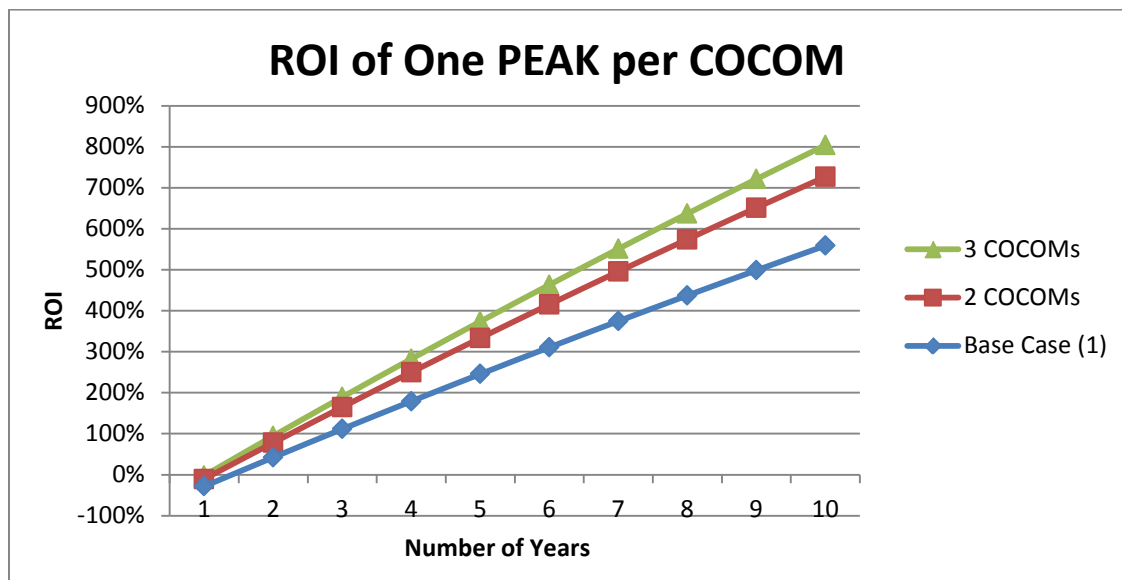


Figure 13. Sensitivity Analysis of ROI with Varying the Number of COCOMs

***b. Number of Standard Disasters per Year***

In our base case, we assume 13 standard disasters and two nonstandard disasters in a year. On the other hand, the historical record indicates a high variability in these annual events. Therefore, it made sense for us to consider the impact of the PEAK if there are different numbers of annual disasters. We analyze the case where there are either fewer, namely 10, or more, namely 16 standard disasters any year. Figure 14 shows the changes in ROIs over time, with varying the number of standard-disasters with one PEAK. The ROI is greater when the greater number of standard disasters occur.

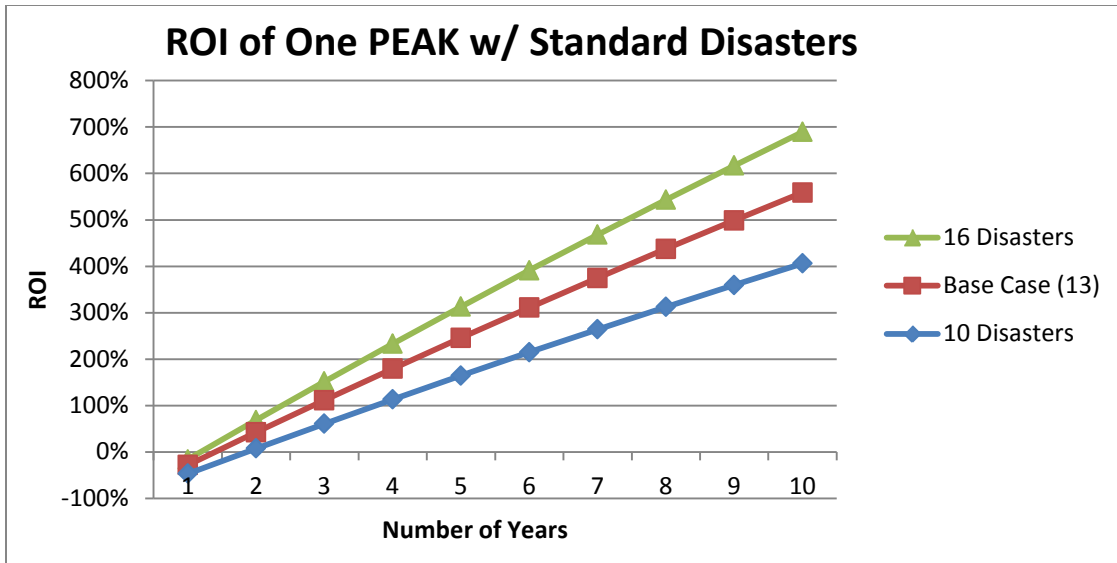


Figure 14. Sensitivity Analysis of ROI with Varying the Number of Standard Disasters

**c. Number of Non-standard Disasters**

As described in Section 8b (Number of Standard Disasters), it made sense for us to consider the impacts to the PEAK ROI if there are different numbers of standard disasters per year. We now analyze and compare the cases where the number of non-standard disasters range from one to three. Figure 15 depicts the changes in ROIs with varying the number of non-standard disasters with one PEAK. The ROI is greater when the greater number of non-standard disasters occurs.

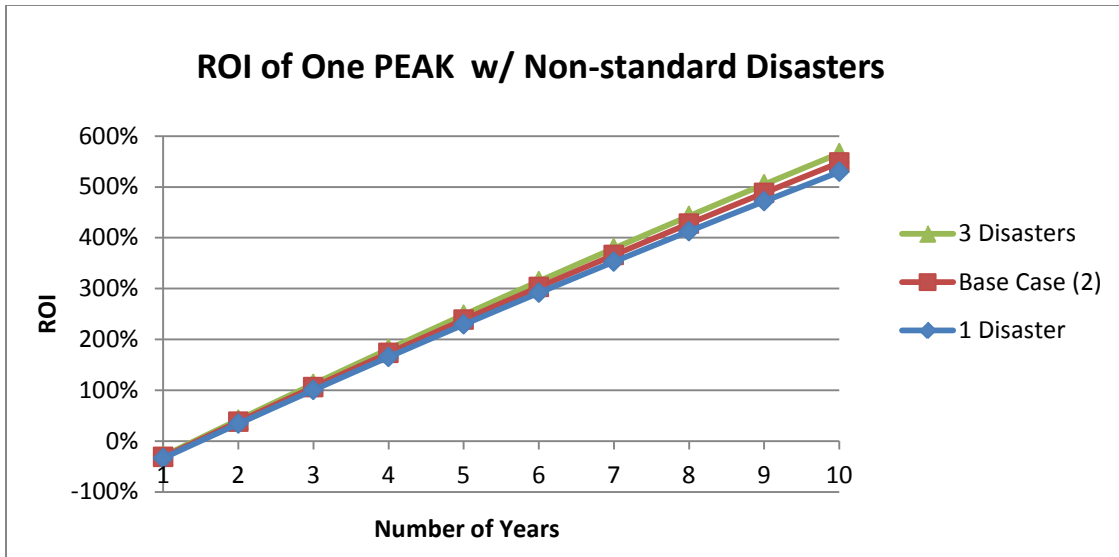


Figure 15. Sensitivity Analysis of ROI with Varying the Number of Non-standard Disasters

#### **d. Investment Cost of the PEAK**

Figure 16 shows the time-phased changes in ROIs with varying the PEAK investment costs. Many projects overrun their cost estimates in the investment phase. We analyze the impact of ROI if the PEAK experiences an overrun. We consider a base case cost of \$932.5K and compare it with an overrun case of the cost of \$2,037.5K. The break-even point is slightly earlier with an investment cost of \$2,037.5K compared with an investment cost of \$932.5K. \$2,037.5K was used for the total investment of one PEAK for each of three COCOMs. The ROI gap in comparing the two cases increases with time.

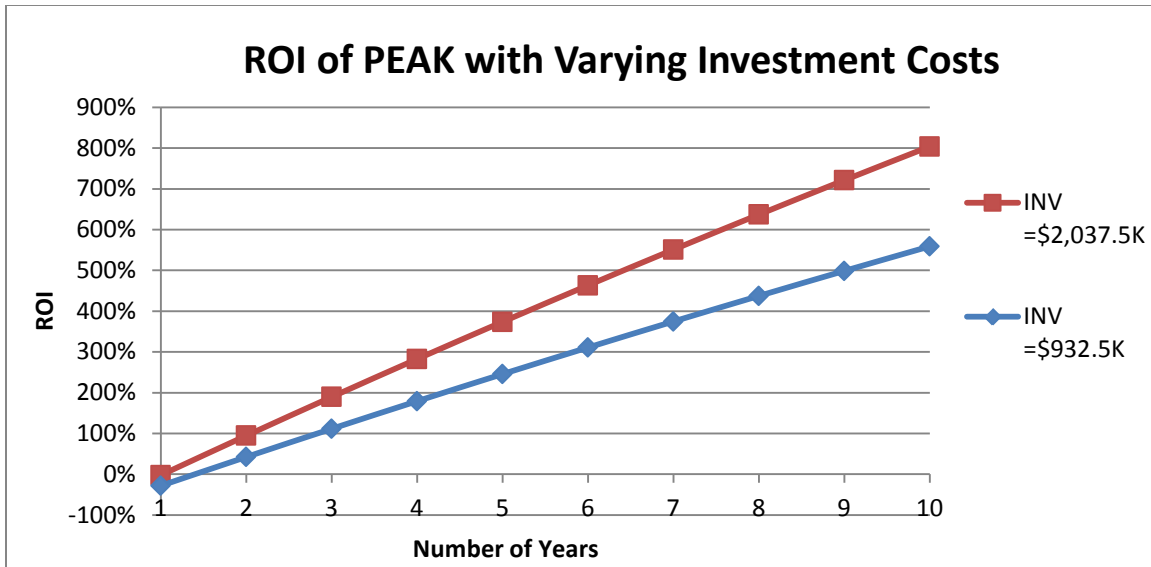


Figure 16. Sensitivity Analysis of Investment Cost of the PEAK (FY12\$K)

## 9. Non-quantifiable Benefits

While the PEAK provides quantifiable benefits of water and transportation savings, it also provides non-quantifiable benefits. An example of non-quantifiable benefits is "soft savings," defined as benefits that result from an initiative, but that cannot result in a savings to a program (Naval Sea Systems Command, 2005). The PEAK's soft savings are enhanced ability of net assessment, support of HA/DR operations, and promotion of security and stability in theater.

The PEAK enhances the local commander's ability to assess the current situation by providing immediate information sharing and situational awareness. The PEAK supports emergency responses by providing rapidly available communication systems to support emergency evacuations.

The PEAK supports HA/DR operations by providing effective and sustainable services through generating water, power, and communications. HA/DR is one of five expanded core capabilities for the Navy, Marine Corps, and Coast Guard enumerated in A Cooperative Strategy for 21st Century Seapower (Department of the Navy, 2007). The important roles of HA/DR operations are



enhancing the security of the United States and improving the general welfare of people around the globe (National Military Strategy of the United States of America , 2011).

The PEAK promotes security and stability in theater through supporting Stability Operations, which are becoming an important aspect of military operations and various activities conducted outside the U.S., in coordination with other instruments of power to maintain a safe and secure environment and to provide essential government services, emergency infrastructure reconstruction, and humanitarian relief (Office of the Chairman of the Joint Chiefs of Staff, 2011). Successful HA/DR and Stability Operations improve the affected country's political perspective of the U. S. to solidify existing partnerships with key nations, and open access to new relationships between nations, non-governmental organizations, and international organizations (Office of the Chairman of the Joint Chiefs of Staff, 2011). The PEAK is a major link between HA/DR and Stability Operations.

## V. CONCLUSIONS

The BCA compares the Life-Cycle Cost (LCC) and benefit estimates of the status quo (existing) systems with the PEAK over a 10-year base case scenario. The analysis considers both a base case and several sensitivity analyses. The results are:

- PEAK provides enhanced ability of net assessment, supports HA/DR operations, and promotes security and stability in theater.
- The LCCE for acquiring and operating the status quo is \$655.5K, while the PEAK system is \$1,378.3K.
- The Net Present Value (NPV) of the PEAK in the base case scenario is \$5,211.6K. This positive value indicates the attractiveness of an investment in the PEAK.
- All PEAK investment costs are recouped after the first year of operation. The system has a positive ROI of 559% over 10 years.
- Increased use of the PEAK generates increased savings. These savings can be achieved by expanding use among COCOMs or by increasing the density of the PEAKs within a COCOM.
- The savings come from cost of water and transportation. Water savings occur because the PEAK replaces the water costs that would normally occur, under the status quo, during an initial period of a disaster.

LCC and benefit estimates show that the PEAK system offers the U. S. DoD positive ROI and NPV after the first year of using one PEAK system in an operational scenario of 10 years. Using the PEAK will save money and reduce time compared to the status quo. The PEAK provides effective and sustainable services in support of U.S. operations and promotes security and stability in theater.

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## APPENDIX A. PEAK DESIRED CAPABILITIES AND METRICS

The below tables are provided as desired capabilities and metrics for PEAK situational awareness, communications, water purification, and power generation. (Office of the Secretary of Defense, 2010a)

**1. Situational awareness**—local situational awareness and information sharing on threats, local populace, services, environment, infrastructure, and other support personnel to enable first responders and decision makers to respond effectively to a time-sensitive event.

Requirement	ID #	Technical Specifications
Identify Event Information Requirements	SA1	<ol style="list-style-type: none"> <li>1. Provide a system for compiling and disseminating information requirements to local information collectors, local commander and others via reach back (if available)</li> <li>2. System to include templates, in English, with pull-down menu, check boxes, question tree, fill-able forms, free text, image annotation, etc, for a selection of use cases for civil-military operations</li> <li>3. Utilize commonly used open-source data formats</li> <li>4. Utilize open-source programming language</li> <li>5. Capability for disconnected use</li> <li>6. Support HTTP and HTTPS protocols</li> </ol>
Collect information	SA2	<ol style="list-style-type: none"> <li>1. Handheld device (ie smart phone) with applications for template/survey input (internet, SMS, cell phone network), imagery/video attachment, walking maps, GPS, voice recording, etc</li> <li>2. Remote sensing device to provide: <ul style="list-style-type: none"> <li>- Video with in-picture information re geo-position, elevation and direction</li> <li>- Still photos with one mil resolution (1' at 1000') and in-picture information re geo-position, elevation and direction</li> <li>- Thermal imaging capability</li> </ul> </li> <li>3. All imagery to be digital, with metadata, in preferred formats: <ul style="list-style-type: none"> <li>- Still photo: H.264/GEOTIFF</li> <li>- Video: MPEG2</li> </ul> </li> <li>4. Capability to print images/maps, and to scan annotated prints/documents, etc (ie. printer/scanner)</li> </ol>

Requirement	ID #	Technical Specifications
Present Information to Support Analysis	SA3	<ol style="list-style-type: none"> <li>1. Receipt of information via email, text, Bluetooth, USB, multinational Cell phone formats, etc</li> <li>2. GIS-based display (ie Google Maps) that accepts and links to free text, templates, imagery, audio, etc (ie push-pins, KML file) from human and remote sensing sources</li> <li>3. Maps and baseline imagery of AOR resident on hard drive</li> <li>4. Imagery available within 5 seconds of file selection</li> <li>5. Reporting format, in English, that is tailor-able for a selection of use cases for civil-military operations</li> </ol>
Disseminate Information	SA4	<ol style="list-style-type: none"> <li>1. Minimize file size to conserve bandwidth for transmission on any available comms system.</li> <li>2. Provide options to transmit information via text, imagery (raw or product), voice, hardcopy, etc.</li> <li>3. Provide automatic version control</li> <li>4. Provide data security options</li> </ol>
Component Portability	SA5	<ol style="list-style-type: none"> <li>1. Man portable per Mil Std 881</li> <li>2. Capable of passing DOD military transport vehicle vibration test.</li> </ol>
Transportability	SA6	<ol style="list-style-type: none"> <li>1. Capable of passing DOD military transport vehicle vibration test</li> <li>2. Weight less than 150 lb (preferably less than 100 lb)</li> <li>3. Volume less than 75 cu ft (preferably less than 50 cu ft)</li> <li>4. No special cargo handling or HAZMAT</li> <li>5. Light truck or trailer portable</li> </ol>
Training	SA7	<ol style="list-style-type: none"> <li>1. Training manuals, in English, with maximum use of simple illustrations</li> <li>2. Training for operations and routine maintenance less than 2 days (preferably 1 day)</li> <li>3. Training for analysis and reporting less than 8 hrs (preferably 4 hrs)</li> </ol>
Environmental Standards	SA8	<ol style="list-style-type: none"> <li>1. Comply with MILSTD 8-10G environmental test standards</li> <li>2. Storage: 0F to 160F for 30 days</li> <li>3. Operating temperature: 0F to 120F for 3 days</li> </ol>

**2. Communications**—Desired capability for local, national/regional, and international communication to transmit/receive voice, data, and images.

Requirement	ID #	Technical Specifications
Send and Receive Data	C1	Note: Preferred comms solution will be based on a network of “smart phones” (to take advantage of global availability and familiarity) 1. Establish local network with minimum 2 NM radius area of operations, capable of supporting minimum 20 operators 2. Exploit and integrate with existing communications networks 3. Provide link to www (ie SATCOM) 4. Provide capability for automatic integration with multi-media/multi-format communications systems 5. Maximum Power Consumption not to exceed 1.25 Kw 6. Provide bandwidth of at least 28 kbps (56 kbps preferred)
Component Portability	C2	1. Man portable per Mil Std 881 2. Capable of passing DOD military transport vehicle vibration test.
Transportability	C3	1. Capable of passing DOD military transport vehicle vibration test 2. Weight less than 150 lb (preferably less than 100 lb) 3. Volume less than 75 cu ft (preferably less than 50 cu ft) 4. No special cargo handling or HAZMAT 5. Light truck or trailer portable
Training	C4	1. Training manuals in English, with maximum use of simple illustrations 2. Maximum one day of training for operations and routine maintenance
Environmental Standards	C5	1. Comply with MILSTD 8-10G environmental test standards 2. Storage: 0F to 160F for 30 days 3. Operating temperature: 0F to 120F for 3 days

### 3. Water Purification—Desired capability for production of potable water from local sources.

Requirement	ID #	Technical Specifications
Purification	W1	<ol style="list-style-type: none"> <li>1. Desal: 35K to &lt; 1000 mg/L or less</li> <li>2. Reduce microbial contaminants 6, 4, 3 log for bacteria, virus &amp; protozoa respectively</li> <li>3. Maintain functional requirements for purification and production in 35k TDS &amp; 50 NTU turbidity at 35F to 95F H2O temps</li> <li>4. Provide primary and secondary disinfection (secondary = residual) of NLT 2 Mg/L point of production and NLT 1mg/L in storage</li> <li>5. Components required for fuel/water separation</li> <li>6. Capability to test source and product water: product water quality testing should monitor TDS, turbidity, pH, and FAC (or disinfectant used) and microbiological indicator organism (P/A of coliforms &amp; E.coli)</li> </ol>
Water Production Quantity	W2	<ol style="list-style-type: none"> <li>1. Produce 600 gallons in 20 hrs (preferably 1800 gallons in 20 hrs)</li> </ol> <p>Note: Flow rate normalized to 77F</p>
Water Storage	W3	<ol style="list-style-type: none"> <li>1. Provide means to store 500 gal (preferably 2000 gal) of potable water</li> <li>2. Provide disinfection NLT 1mg/L in storage</li> <li>3. Provide means to distribute product water at a rate NLT 1 gpm (preferably 2 gpm) total through 2 (preferably 4) spigots</li> </ol>
Consumables	W4	<ol style="list-style-type: none"> <li>1. Provide consumables for minimum 14 days (preferably 45 days), within targeted volume limits including filters, cleaning supplies, disinfectant, water testing consumables, etc</li> <li>2. Minimize proprietary parts and specialty tools</li> <li>3. Disposal of consumables not to require handling as HazMat</li> </ol>
Siting Limits	W5	<ol style="list-style-type: none"> <li>1. Capable of operating at a minimum of 50' (preferably 100') from water source.</li> </ol>
Power	W6	<ol style="list-style-type: none"> <li>1. Renewable energy source preferred.</li> <li>2. Less than 20 watt hrs/gal (preferably less than 15wh/g)</li> <li>3. Able to connect to 12/24 DC, 110/220 AC, 50-60Hz</li> <li>4. Provide power supply monitor</li> </ol>
Maintenance	W7	<ol style="list-style-type: none"> <li>1. Routine maintenance: Sustainable by field operator with organic accessories and common plumbing tools for a period not less than 3 days (preferably 6 days)</li> <li>2. Major maintenance: Minimum of 15 days (preferably 30 days) without major maintenance (ie replacement of</li> </ol>

Requirement	ID #	Technical Specifications
		major system components such as motor or primary treatment element) 3. Mean time between servicing at least 300 hrs (preferably 600 hrs) of operation 4. Less than 12 hrs (preferably 6hrs) to perform major maintenance
Component Portability	W8	1. Man portable per Mil Std 881 2. No single component greater than 200 lb.
Transportability	W9	1. Capable of passing DOD military transport vehicle vibration test 2. Weight less than 300 lb (preferably less than 200 lb) 3. Volume less than 100 cu ft (preferably less than 50 cu ft) 4. No special cargo handling or HAZMAT 5. Light truck or trailer portable
Training	W10	1. Provide simplified user manual with extensive visual aids 2. Provide detailed technical manual 3. Time to achieve user proficiency less than 8 hrs (preferably less than 4 hrs)
Environmental Standards	W11	1. Comply with MILSTD 8-10G environmental test standards 2. Storage: 0F to 160F for 30 days 3. Operating temperature: 35F to 120F for 3 days 4. Source water temperature: 35F to 95F
Operational Safety	W12	1. Able to function without operator interaction for at least 1 hour (preferably 2 hrs) 2. Provide continuous water quality monitoring with visible and audible feedback 3. Automatic shut down when operation exceeds specifications 4. Comply with DOD/OSHA safety requirements



**4. Power Generation**—Desired capability for production of reliable power for PEAK components from primarily renewable sources. 1kW power requirement.

Requirement	ID #	Technical Specifications
Power Type	P1	<ol style="list-style-type: none"> <li>1. Generate power from primarily renewable resources</li> <li>2. Supply power to all PEAK components simultaneously at maximum continuous demand of 3kw (preferably 5 kw)</li> <li>3. Battery storage to satisfy peak demand for at least 1 hr (preferably 2 hrs)</li> </ol>
Power Availability	P2	<ol style="list-style-type: none"> <li>1. Provide power to satisfy maximum continuous demand 24/7</li> <li>2. Multi-input power distribution panel</li> <li>3. Support PEAK components with power for operations at three locations with at least 330 ft separation</li> <li>4. Provide 3 auxiliary power GFI outlets: <ul style="list-style-type: none"> <li>- 120V, single phase 2 wire</li> <li>- 120/240V, single phase, 3 wire</li> <li>- 120/240V 3 phase, 4 wire</li> </ul> </li> <li>5. Provide 4 international adapter kits</li> </ol>
Consumables	P3	<ol style="list-style-type: none"> <li>1. Provide consumables for minimum 14 days (preferably 45 days), within targeted volume limits including filters, lubricants, batteries, etc</li> <li>2. Minimize proprietary parts and specialty tools</li> <li>3. Disposal of consumables not to require handling as HAZMAT</li> </ol>
Maintenance	P4	<ol style="list-style-type: none"> <li>1. Routine maintenance: Sustainable by field operator with organic accessories and common tools for a period not less than 60 hrs (preferably 120 hrs)</li> <li>2. Time required to perform routine maintenance less then 1 hr (preferably less than 0.5 hrs)</li> <li>3. Major maintenance: Mean time between failure at least 500 hrs (preferably 750 hrs) of operation</li> <li>4. Time required to perform major maintenance less then 2 hrs (preferably less than 1.5 hrs)</li> <li>5. Readily available replacement parts</li> </ol>

Requirement	ID #	Technical Specifications
Component Portability	P5	<ol style="list-style-type: none"> <li>1. Man portable per Mil Std 881</li> <li>2. No single component greater than 200 lb</li> </ol>
Transportability	P6	<ol style="list-style-type: none"> <li>1. Weight less than 300 lb (preferably 200 lb)</li> <li>2. Volume less than 100 cu ft (preferably less than 50 cu ft)</li> <li>3. Capable of passing DOD military transport vehicle vibration test</li> <li>4. No special cargo handling or HAZMAT</li> <li>5. Light truck or trailer portable</li> </ol>
Training	P7	<ol style="list-style-type: none"> <li>1. Provide simplified user manual with extensive visual aids</li> <li>2. Provide detailed technical manual</li> <li>3. Time to achieve user proficiency less than 8 hrs (preferably less than 4 hrs)</li> </ol>
Environmental Standards	P8	<ol style="list-style-type: none"> <li>1. Comply with MILSTD 8-10G environmental test standards</li> <li>2. Storage: 0F to 160F for 30 days</li> <li>3. Operating temperature: 0F to 120F for 3 days</li> </ol>
Operational Safety	P9	<ol style="list-style-type: none"> <li>1. Able to function without operator interaction for at least 2 hrs (preferably 4 hrs)</li> <li>2. Provide means to monitor power performance</li> <li>3. Provide embedded diagnostic capability</li> <li>4. Provide push button start and stop with manual start as backup</li> <li>5. Comply with DOD/OSHA safety requirements</li> </ol>

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## APPENDIX B. OFDA Funding Summary (FY 2009)

The below table is provided as OFDA funding summary for FY 2009. The table includes declared disasters and obligations from all world regions during FY 2009. (United States Agency for International Development, 2009b)

Funding Summary - FY 2009 Declared Disasters						
Obligations from October 1, 2008 - September 30, 2009						
Country	Disaster	Declaration Date	Affected	Dead <sup>1</sup>	Obligation	Disaster Assistance Provided by OFDA
Global	Influenza A/H1N1	-	340,000	4,100	\$46,223	RMT activated to coordinate USG response; health activities
Subtotal Global					\$46,223	
Africa						
Angola	Floods	03/17/09	220,000	60	\$501,475	Deployment of assessment team to evaluate humanitarian conditions; local procurement of emergency relief supplies; logistics and shelter and settlements activities
Burkina Faso	Measles Outbreak	05/11/09	51,000	300	\$250,000	Procurement of measles vaccines and vaccination supplies
Burkina Faso	Floods	09/02/09	150,000	8	\$1,450,000	Agriculture and food security, economic recovery and market systems, and WASH activities
CAR	Complex Emergency	03/02/09	32,000	-	\$292,410	Provision of emergency relief supplies; health activities
Chad	Complex Emergency	10/01/08	1,213,000	-	\$9,784,344	Provision of emergency relief supplies; agriculture and food security, economic recovery and market systems, health, humanitarian coordination and information management, and WASH activities
Comoros	Floods	05/07/09	100,000	2	\$50,000	Agriculture and food security, economic recovery and market systems, humanitarian coordination and information management, and protection activities
Djibouti	Food Insecurity	10/30/08	441,000	-	\$1,298,980	Deployment of a regional advisor to assess food security conditions; nutrition activities
DRC	Complex Emergency <sup>2</sup>	10/14/08	2,100,000	5,400,000*	\$32,977,698	Deployment of a DART to conduct assessments and coordinate with government and relief agencies; provision of emergency relief supplies; agriculture and food security, economic recovery and market systems, nutrition, protection, shelter and settlements, health, humanitarian coordination and information management, and WASH activities
Ethiopia	Complex Emergency	10/06/08	6,200,000	-	\$61,276,990	Deployment of a Humanitarian Assistance Team to conduct assessments and coordinate with government and relief agencies; provision of emergency relief supplies; local food procurement; agriculture and food security, economic recovery and market systems, health, humanitarian coordination and information management, logistics, nutrition, risk reduction, and WASH activities
Kenya	Food Security Crisis	10/29/08	3,800,000	-	\$24,253,180	Agriculture and food security, economic recovery and market systems, nutrition, health, local food procurement, and WASH activities
Liberia	Caterpillar Infestation	02/03/09	500,000	-	\$100,000	Humanitarian coordination and information management and WASH activities
Madagascar	Cyclone and Storm	02/03/09	101,218	25	\$891,255	Provision of emergency relief supplies; agriculture and food security, economic recovery and market systems, and natural and technological risks activities
Madagascar	Complex Emergency	03/25/09	1,000	150	\$227,502	Provision of emergency relief supplies; agriculture and food security activities
Mauritania	Floods	09/09/09	10,000	1	\$25,100	WASH activities
Mozambique	Food Price Crisis	-	247,000	0	\$5,000,000	Local/Regional procurement of food aid
Namibia	Floods	03/18/09	350,000	92	\$700,000	Deployment of assessment team to evaluate humanitarian conditions; provision of emergency relief supplies; shelter and settlements and WASH activities
Niger	Floods	09/16/09	100,000	3	\$50,000	WASH activities
Senegal	Floods	09/17/09	350,000	4	\$50,000	Provision of emergency relief supplies; WASH activities

Somalia	Complex Emergency	10/31/08	3,800,000	-	\$9,170,450	Provision of emergency relief supplies, agriculture and food security, economic recovery and market systems, health, nutrition, protection, regional food procurement, and WASH activities
Sudan	Complex Emergency	10/16/08	8,000,000*	-	\$139,949,736	Provision of emergency relief supplies; agriculture and food security, health, nutrition, economic recovery and market systems, humanitarian coordination and information management, protection, shelter and settlements, and WASH activities
Sudan	Floods	09/23/09	111,455	20	\$50,000	WASH activities
Tanzania	Munitions Explosion	05/06/09	18,800	26	\$50,000	Provision of emergency relief supplies
Uganda	Food Security Crisis	11/03/08	1,100,000	-	\$5,000,000	Agriculture and food security and economic recovery and market systems activities
West Africa	Food Price Crisis	-	-	-	\$30,710,231	Agriculture and food security, economic recovery and market systems, and nutrition activities
Zimbabwe	Complex Emergency	10/06/08	7,100,000	-	\$23,623,876	Provision of emergency relief supplies; local/regional procurement of food aid; health, protection, nutrition, agriculture and food security, economic recovery and market systems, humanitarian coordination and information management, natural and technological risks, and WASH activities
Zimbabwe	Cholera Outbreak	12/15/08	98,592	4,288	\$7,311,374	Deployment of a DART to conduct assessments and coordinate with government and relief agencies; provision of emergency relief supplies; health, WASH, and natural and technological risks activities
Subtotal Africa					\$355,044,601	
Asia and the Pacific						
Bangladesh	Cyclone	05/28/09	4,800,000	190	\$3,620,188	Deployment of regional advisor and shelter specialist to conduct assessments and coordinate with government and relief agencies; airlift of emergency relief supplies; economic recovery and market systems, shelter and settlements, and WASH activities
Fiji	Floods	01/14/09	9,000	11	\$50,000	Provision of emergency relief supplies
Indonesia	Earthquake	09/04/09	180,000	81	\$100,000	Deployment of regional advisor and shelter specialist to conduct assessments and coordinate with government and relief agencies; provision of emergency relief supplies
Laos	Floods	10/01/09	178,000	17	\$50,000	Deployment of a regional advisor to assess humanitarian conditions; provision of emergency relief supplies
Nepal	Food Price Crisis	-	2,500,000	-	\$5,000,000	Local/Regional procurement of food aid
Pakistan	Complex Emergency	10/20/08	2,700,000	-	\$102,552,961	Deployment of a DART to conduct assessments and coordinate with government and relief agencies; activation of Washington, D.C.-based RMT; provision of emergency relief supplies; economic recovery and market systems, health, humanitarian coordination and information management, nutrition, protection, shelter and settlements, and WASH activities
Pakistan	Earthquake <sup>3</sup>	10/31/08	68,200	166	\$2,333,367	Deployment of a DART to conduct assessments and coordinate with government and relief agencies; provision of emergency relief supplies; shelter and settlements and WASH activities
Papua New Guinea	Floods	12/18/08	75,300	-	\$150,000	Provision of emergency relief supplies
Philippines	Complex Emergency	10/31/08	511,090	-	\$246,041	WASH activities
Philippines	Tropical Storm <sup>4</sup>	09/28/09	4,929,382	464	\$246,222	Deployment of a regional advisor and field officer to assess humanitarian conditions; airlift and provision of emergency relief supplies

Country	Disaster	Declaration Date	Affected	Dead <sup>1</sup>	Obligation	Disaster Assistance Provided by OFDA
Solomon Islands	Floods	02/13/09	20,000	10	\$50,000	Provision of emergency relief supplies
Sri Lanka	Complex Emergency	10/21/08	253,000	-	\$7,935,926	Deployment of field team and WASH advisors to assess humanitarian conditions; provision of emergency relief supplies; agriculture and food security, economic recovery and market systems, health, humanitarian coordination and information management, protection, and WASH activities
Sri Lanka	Floods	12/01/08	360,000	15	\$100,000	Provision of emergency relief supplies
Taiwan	Typhoon	08/11/09	6,000	376	\$250,000	Deployment of two regional advisors to assess humanitarian conditions; provision of emergency relief supplies
Vietnam	Floods	11/13/08	600,000	89	\$50,000	Provision of emergency relief supplies
Subtotal Asia and the Pacific					\$122,734,705	
Europe, Middle East, and Central Asia						
Afghanistan	Complex Emergency	10/20/08	260,000	-	\$27,298,157	Provision of emergency relief supplies; economic recovery and market systems, natural and technological risks, humanitarian coordination and information management, shelter and settlements, and WASH activities
Gaza	Complex Emergency	-	900,000	-	\$334,442	Provision of emergency relief supplies
Iraq	Complex Emergency	-	2,500,000*	-	\$83,420,750	Provision of emergency relief supplies; humanitarian coordination and information management, health, nutrition, protection, and WASH activities
Italy	Earthquake	04/06/09	1,000	290	\$50,000	Provision of emergency relief supplies
Kyrgyzstan	Earthquake	10/08/08	860	75	\$50,000	Provision of emergency relief supplies to support construction of a heating system and mobile bathhouses for affected populations
Kyrgyzstan	Food Price Crisis	-	2,000,000	-	\$7,069,847	Local/Regional procurement of food aid
Tajikistan	Mudslides and Floods	05/22/09	15,000	28	\$50,000	Provision of emergency relief supplies; WASH activities
Yemen	Floods	10/27/08	25,000	98	\$349,000	Provision of emergency relief supplies
Yemen	Complex Emergency	09/08/09	150,000*	-	\$250,000	Health, nutrition, and WASH activities
Subtotal Europe, Middle East, and Central Asia					\$118,872,196	

Country	Disaster	Declaration Date	Affected	Dead <sup>1</sup>	Obligation	Disaster Assistance Provided by OFDA
Latin America and the Caribbean						
Belize	Floods	10/27/08	38,000	-	\$50,000	Deployment of disaster risk management specialist and field officer to assess humanitarian conditions; provision of emergency relief supplies
Brazil	Floods	11/25/08	69,000	120	\$100,000	Deployment of assessment team to evaluate humanitarian conditions; provision of emergency relief supplies
Brazil	Floods	05/01/09	1,200,000	56	\$200,000	Deployment of assessment team to evaluate humanitarian conditions; provision of emergency relief supplies
Colombia	Floods	12/22/08	1,200,000	76	\$150,000	Provision of emergency relief supplies
Colombia	Floods	02/24/09	31,320	1	\$125,000	Provision of emergency relief supplies, WASH activities
Costa Rica	Floods <sup>5</sup>	11/26/08	46,000	-	\$143,448	Deployment of assessment team to evaluate humanitarian conditions; airlift and provision of emergency relief supplies
Costa Rica	Earthquake	01/09/09	2,943	23	\$50,000	Logistical support for the rental of helicopters to assist evacuation of affected populations
Guatemala	Floods	11/06/08	48,000	3	\$74,997	Deployment of a disaster risk management specialist to assess humanitarian conditions; provision of emergency relief supplies
Haiti	Accident	-	250	100	\$1,111,954	Deployment of a Fairfax County Urban Search and Rescue team and support staff to join a DART already in country and assist search and rescue efforts, advise recovery and demolition efforts, and conduct damage assessments.
Honduras	Floods	10/21/08	320,000	70	\$436,072	Deployment of assessment team to evaluate humanitarian conditions; airlift and local procurement of emergency relief supplies
Mexico	Hurricane	09/14/09	72,000	4	\$299,135	Deployment of assessment team to evaluate humanitarian conditions; provision of emergency relief supplies
Panama	Floods <sup>6</sup>	11/24/08	7,400	5	\$164,798	Deployment of assessment team to evaluate humanitarian conditions; airlift and provision of emergency relief supplies
Subtotal Latin America and the Caribbean					\$2,905,404	
TOTAL FY 2009 DISASTER RESPONSE					\$599,603,129	

Notes:

\* This figure represents the cumulative total of deaths or affected individuals since the onset of the complex emergency.

1) A hyphen (-) in the dead and/or affected columns indicates that reliable information was not available.

2) OFDA also provided stockpiled commodities valued at \$949,250, bringing total OFDA emergency assistance to DRC to \$33,926,948.

3) OFDA also provided stockpiled commodities valued at \$193,450, bringing total OFDA emergency assistance for the Pakistan earthquake to \$2,526,817.

4) OFDA also provided stockpiled commodities valued at \$158,274, bringing total OFDA emergency assistance for the Philippines tropical storm to \$404,496.

5) OFDA also provided stockpiled commodities valued at \$129,036, bringing total OFDA emergency assistance to Costa Rica for floods to \$272,484.

6) OFDA also provided stockpiled commodities valued at \$85,536, bringing total OFDA emergency assistance to Panama to \$250,334.

## APPENDIX C. OFDA Funding Summary (FY 2010)

The below table is provided as OFDA funding summary for FY 2010. The table includes declared disasters and obligations from all world regions during FY 2010. (United States Agency for International Development, 2010)

Funding Summary - FY 2010								
Obligations from October 1, 2009 - September 30, 2010								
Country/Region	Disaster Type	Declaration Date	Assistance Types					Total
			Disaster Response	Disaster Response with DRR Components	DRR	Operational Readiness	Other	
DISASTERS								
Africa								
Angola	Refugee Returns	12/16/09	\$50,000					\$50,000
Burkina Faso	Floods	10/02/09	\$604,801					\$604,801
Burkina Faso	Floods	08/10/10	\$50,000					\$50,000
Cameroon	Cholera Outbreak	08/26/10	\$50,000					\$50,000
Cape Verde	Floods	10/28/09	\$25,000					\$25,000
Chad	Complex Emergency	12/03/09	\$5,950,000	\$2,626,710			\$53,406	\$8,630,116
DRC	Complex Emergency	10/07/09	\$22,714,960		\$575,000	\$10,471	\$600,185	\$23,900,616
Ethiopia	Complex Emergency	10/05/09	\$16,426,399	\$5,962,099		\$5,315	\$845,500	\$23,239,313
Ghana	Floods	10/05/09	\$50,000					\$50,000
Kenya	Food Insecurity	10/01/09	\$211,553	\$8,929,068	\$1,063,935			\$10,204,556
Madagascar	Food Insecurity	10/30/09	\$300,000					\$300,000
Madagascar	Cyclone	03/17/10	\$900,077					\$900,077
Malawi	Earthquakes	12/21/09	\$50,000		\$500,743			\$550,743
Mali	Food Insecurity	02/19/10	\$50,000					\$50,000
Niger	Floods	10/05/09	\$500,000					\$500,000
Niger	Food Insecurity	01/14/10	\$13,721,339	\$886,602	\$1,698,367			\$16,306,308
Nigeria	Lead Poisoning	08/27/10	\$80,000					\$80,000
Senegal	Floods	10/05/09	\$186,062	\$232,558	\$127,428			\$546,048
Somalia	Complex Emergency	10/01/09	\$1,894,193	\$14,772,882				\$16,667,075
Sudan	Complex Emergency	10/01/09	\$62,879,025	\$25,245,859	\$472,700	\$29,013	\$4,230,241	\$92,856,838
Sudan	Floods	09/07/10	\$50,000					\$50,000
Tanzania	Floods	01/11/10	\$50,000					\$50,000
Uganda	Landslides and Floods	03/04/10	\$50,000					\$50,000
Zimbabwe	Complex Emergency	10/15/09	\$17,280,539	\$1,156,557	\$1,933,332		\$26,907	\$20,397,335
Total			\$144,123,948	\$59,812,335	\$6,371,505	\$44,799	\$5,756,239	\$216,108,826
Africa Total			\$144,123,948	\$59,812,335	\$6,371,505	\$44,799	\$5,756,239	\$216,108,826
Asia and the Pacific								
China	Earthquake	04/14/10	\$404,728					\$404,728
China	Floods	06/24/10	\$100,000					\$100,000
China	Floods	07/30/10	\$50,000					\$50,000
China	Landslides	08/10/10	\$50,000					\$50,000
Democratic People's Republic of Korea	Floods	08/26/10	\$600,001					\$600,001
Fiji	Cyclone	03/17/10	\$100,000					\$100,000
India	Floods	10/07/09	\$100,000					\$100,000
India	Floods	09/09/10	\$50,000					\$50,000
Indonesia	Earthquake	10/01/09	\$5,819,354	\$2,019,766				\$7,839,120
Indonesia	Volcano	08/30/10	\$50,000					\$50,000
Laos	Floods	10/01/09	\$350,000					\$350,000
Mongolia	Winter Emergency	02/22/10	\$299,625					\$299,625
Pakistan	Complex Emergency	10/09/09	\$15,933,729	\$805,077	\$872,553	\$4,762	\$934,410	\$18,550,531
Pakistan	Landslides	01/10/10	\$50,000					\$50,000



## Funding Summary - FY 2010

Obligations from October 1, 2009 - September 30, 2010

Country/Region	Disaster Type	Declaration Date	Assistance Types					Total
			Disaster Response	Disaster Response with DRR Components	DRR	Operational Readiness	Other	
DISASTERS								
Pakistan	Floods	07/30/10	\$107,201,307	\$7,804,414				\$115,005,721
Philippines	Tropical Storms	10/07/09	\$5,799,464	\$222,953				\$6,022,417
Philippines	Volcano	12/29/09	\$50,000					\$50,000
Samoa	Tsunami	10/01/09	\$1,412,997		\$8,013			\$1,421,010
Solomon Islands	Tsunami	01/06/10	\$75,000					\$75,000
Sri Lanka	Complex Emergency	12/04/09	\$5,458,333	\$4,268,059			\$16,521	\$9,742,913
Sri Lanka	Floods	05/20/10	\$50,000					\$50,000
Tonga	Tsunami	10/06/09	\$50,000					\$50,000
Vietnam	Typhoon	10/01/09	\$1,005,750					\$1,005,750
Total			\$145,060,288	\$15,120,269	\$880,566	\$4,762	\$950,931	\$162,016,816
Prior Year Disaster Cost - Replenishment of Relief Commodities								
Burma	Cyclone		\$548,848					\$548,848
Pakistan	Earthquake		\$193,450					\$193,450
Philippines	Typhoon		\$80,248					\$80,248
Total			\$822,546	\$0	\$0	\$0	\$0	\$822,546
Asia and the Pacific Total			\$145,882,834	\$15,120,269	\$880,566	\$4,762	\$950,931	\$162,839,362

<b>Europe, the Middle East, and Central Asia (EMCA)</b>								
Afghanistan	Complex Emergency	05/16/10	\$17,794,182	\$10,539,840	\$1,272,406		\$321,589	\$29,928,017
Albania	Floods	01/13/10	\$50,000					\$50,000
Bosnia and Herzegovina	Floods	06/29/10	\$51,129					\$51,129
Hungary	Floods	06/09/10	\$50,000					\$50,000
Iraq	Complex Emergency	10/06/09	\$40,148,343		\$500,000	\$6,864	\$294,891	\$40,950,098
Kyrgyzstan	Complex Emergency	04/13/10 and 06/12/10	\$4,367,542	\$5,442,761			\$22,976	\$9,833,279
Moldova	Floods	07/09/10	\$50,000					\$50,000
Poland	Floods	05/21/10	\$50,000					\$50,000
Portugal	Floods	02/22/10	\$50,000					\$50,000
Romania	Floods	07/09/10	\$50,000					\$50,000
Russia	Wildfires	08/06/10	\$881,750					\$881,750
Tajikistan	Floods	12/03/09	\$1,015,202	\$670,500				\$1,685,702
Tajikistan	Floods	05/12/10	\$50,000					\$50,000
Uzbekistan	Complex Emergency	06/14/10	\$50,000					\$50,000
Yemen	Complex Emergency	-	\$10,558,483	\$370,157				\$10,928,640
<b>Total</b>			<b>\$75,216,631</b>	<b>\$17,023,258</b>	<b>\$1,772,406</b>	<b>\$6,864</b>	<b>\$639,456</b>	<b>\$94,658,615</b>
<b>Prior Year Disaster Cost - Replenishment of Relief Commodities</b>								
Georgia	Complex Emergency		\$72,000					\$72,000
<b>EMCA Total</b>			<b>\$75,288,631</b>	<b>\$17,023,258</b>	<b>\$1,772,406</b>	<b>\$6,864</b>	<b>\$639,456</b>	<b>\$94,730,615</b>

<b>Latin America and the Caribbean (LAC)</b>								
Brazil	Floods	04/08/10	\$50,000					\$50,000
Brazil	Floods	06/22/10	\$112,333					\$112,333
Chile	Earthquake	02/28/10	\$8,387,000	\$448,821			\$37,721	\$8,873,542
Colombia	Wildfires	01/11/10	\$701,058					\$701,058
El Salvador	Floods	11/10/09	\$834,548					\$834,548

## Funding Summary - FY 2010

Obligations from October 1, 2009 - September 30, 2010

Country/Region	Disaster Type	Declaration Date	Assistance Types					Total
			Disaster Response	Disaster Response with DRR Components	DRR	Operational Readiness	Other	
DISASTERS								
El Salvador	Tropical Storm	05/31/10	\$150,000					\$150,000
Guatemala	Tropical Storm and Volcano	05/30/10	\$1,034,744	\$442,252				\$1,476,996
Guatemala	Floods	09/06/10	\$100,000					\$100,000
Haiti	Earthquake	01/13/10	\$278,496,448	\$88,772,928		\$8,125	\$311,498	\$367,588,999
Honduras	Tropical Storm	05/31/10	\$50,000					\$50,000
Mexico	Hurricane	07/10/10	\$482,469					\$482,469
Total			\$290,398,600	\$89,664,001	\$0	\$8,125	\$349,219	\$380,419,945
Prior Year Disaster Cost - Replenishment of Relief Commodities								
Costa Rica	Flood		\$129,036					\$129,036
Haiti	Hurricane		\$641,956					\$641,956
Jamaica	Storm		\$149,752					\$149,752
Panama	Flood		\$85,536					\$85,536
Total			\$1,006,280	\$0	\$0	\$0	\$0	\$1,006,280
LAC Total			\$291,404,880	\$89,664,001	\$0	\$8,125	\$349,219	\$381,426,225
Disasters Total			\$656,700,293	\$181,619,863	\$9,024,477	\$64,550	\$7,695,845	\$855,105,028

Country/Region or Program	Assistance Types					Total
	Disaster Response	Disaster Response with DRR Components	DRR	Operational Readiness	Other	
REGIONAL AND GLOBAL DISASTER SUPPORT						
Africa						
Djibouti		\$1,000,000				\$1,000,000
East and Central Africa				\$29,438	\$65,076	\$94,514
Southern Africa	\$320,259	\$11,887	\$6,459,247			\$6,791,393
West Africa		\$27,904	\$6,850,000		\$20,964	\$6,898,868
Total	\$320,259	\$1,039,791	\$13,309,247	\$29,438	\$86,040	\$14,784,775
Asia and the Pacific						
Bangladesh			\$53,000			\$53,000
Burma			\$234,250			\$234,250
China			\$1,557,543			\$1,557,543
East Asia and Pacific	\$4,907		\$1,560,000	\$27,089	\$142,874	\$1,734,870
FSM and RMI			\$938,200	\$7,042	\$237,116	\$1,182,358
India			\$199,281			\$199,281
Indonesia			\$621,480			\$621,480
Pacific			\$750,000			\$750,000
South Asia			\$1,920,558	\$17,596	\$53,386	\$1,991,540
Total	\$4,907	\$0	\$7,834,312	\$51,727	\$433,376	\$8,324,322

## Funding Summary - FY 2010

Obligations from October 1, 2009 - September 30, 2010

Country/Region or Program	Assistance Types					Total
	Disaster Response	Disaster Response with DRR Components	DRR	Operational Readiness	Other	
REGIONAL AND GLOBAL DISASTER SUPPORT						
EMCA						
Central Asia			\$146,078			\$146,078
Europe			\$8,335	\$11,582	\$119,393	\$139,310
Total	\$0	\$0	\$154,413	\$11,582	\$119,393	\$285,388
LAC						
Caribbean			\$260,000			\$260,000
Central America	\$50,000	\$357,724	\$99,979			\$507,703
Latin America and Caribbean		\$5,732,334	\$2,295,196	\$2,041		\$8,029,571
South America			\$100,000			\$100,000
Total	\$50,000	\$6,090,058	\$2,755,175	\$2,041	\$0	\$8,897,274
Global						
Agriculture and Food Security			\$7,141		\$398,673	\$405,814
Geohazards			\$1,739,810			\$1,739,810
Hydrometeorological Hazards			\$1,066,000			\$1,066,000
Information Management and Coordination	\$11,012,373	\$1,648,824	\$2,432,252		\$150,213	\$15,243,662
Monitoring and Evaluation		\$349,234	\$4,957			\$354,191
Public Health and Nutrition	\$4,407,890	\$200,000	\$805,000	\$1,701,347	\$70,698	\$7,184,935
Shelter and Settlements					\$6,737	\$6,737
Vulnerable and IDP Protection	\$20,000	\$1,200,000	\$349,938			\$1,569,938
Total	\$15,440,263	\$3,398,058	\$6,405,098	\$1,701,347	\$626,321	\$27,571,087
Regional and Global Disaster Support Total	\$15,815,429	\$10,527,907	\$30,458,245	\$1,796,135	\$1,265,130	\$59,862,846

<b>OPERATIONS AND PROGRAM SUPPORT</b>						
Operations Support	\$16,535		\$51,891	\$14,684,501	\$14,441,821	\$29,194,748
Program Support	\$46,254	\$23,125	\$14,442	\$78,613	\$29,911,415	\$30,073,849
<b>Operations and Program Support Total</b>	<b>\$62,789</b>	<b>\$23,125</b>	<b>\$66,333</b>	<b>\$14,763,114</b>	<b>\$44,353,236</b>	<b>\$59,268,597</b>

<b>SUMMARY - FY 2010 OFDA Funding and Budget Carryover</b>						
Disasters	\$656,700,293	\$181,619,863	\$9,024,477	\$64,550	\$7,695,845	\$855,105,028
Regional and Global Disaster Support	\$15,815,429	\$10,527,907	\$30,458,245	\$1,796,135	\$1,265,130	\$59,862,846
Operations and Program Support	\$62,789	\$23,125	\$66,333	\$14,763,114	\$44,353,236	\$59,268,597
Total FY 2010 Obligated Funding	\$672,578,511	\$192,170,895	\$39,549,055	\$16,623,799	\$53,314,211	\$974,236,470
Budget Carryover to FY 2011						\$332,954,704
<b>Total OFDA Budget for FY 2010</b>						<b>\$1,307,191,174</b>

## APPENDIX D. 2010 OASN(FM&C) JAPAN EARTHQUAKE RELIEF SUMMARY (FY 12\$)

The following tables are provided as the OASN(FM&C) Japan earthquake relief summary. The tables include the monthly summary of expense data during the 2010 Japan earthquake relief operations. (Office of Assistant Secretary of Navy Financial Management and Comptroller, 2011)

Humanitarian Relief Supplies & Materials	15-Mar-11	16-Mar-11	17-Mar-11	18-Mar-11	19-Mar-11	20-Mar-11	21-Mar-11	22-Mar-11	23-Mar-11	24-Mar-11	25-Mar-11	26-Mar-11
Medical Supplies	0.0	0.0	0.0	0.0	0.0	0.0	23.0	26.0	26.0	27.5	27.5	27.5
Health & Comfort Packages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water & Water Storage	22.0	28.2	28.2	28.2	43.2	43.2	43.3	70.5	179.3	219.3	219.3	219.3
Humanitarian Daily Rations	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4	3.4	3.4	3.4	3.4
All Other Humanitarian Relief Supplies	10.0	10.0	10.0	10.0	32.0	32.0	54.0	392.8	54.0	6,963.2	6,965.9	6,965.9
<b>Total Humanitarian Supplies &amp; Materials</b>	<b>32.0</b>	<b>38.2</b>	<b>38.2</b>	<b>38.2</b>	<b>75.2</b>	<b>75.2</b>	<b>123.7</b>	<b>492.7</b>	<b>262.7</b>	<b>7,213.5</b>	<b>7,216.1</b>	<b>7,216.1</b>
Operational Support Costs	15-Mar-11	16-Mar-11	17-Mar-11	18-Mar-11	19-Mar-11	20-Mar-11	21-Mar-11	22-Mar-11	23-Mar-11	24-Mar-11	25-Mar-11	26-Mar-11
Incremental Labor Costs (Includes Civilian Overtime and Contract Labor)	78.5	105.6	136.2	159.4	142.2	207.4	242.3	260.6	312.7	470.0	540.2	552.0
Temporary Duty Costs	33.8	40.0	273.9	339.1	360.6	379.3	812.4	1,107.1	1,256.2	1,441.1	1,591.8	1,987.5
Health Services, Clothing, & Misc Personnel Support	0.0	2.5	40.6	45.4	43.1	50.5	77.6	78.0	183.5	204.7	205.8	210.8
Base Support (Billeting, mess, C4I, & other support for US forces)	237.5	261.0	263.0	263.2	460.9	461.1	520.7	520.7	638.0	1,451.1	1,452.0	2,639.9
Airlift & Aviation Costs	917.0	917.0	3,382.8	4,193.6	4,584.8	4,631.6	4,684.7	4,760.3	6,908.3	7,548.2	8,347.6	9,149.5
Sealift & Steaming Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	6,336.6
Port Handling & Misc Transportation Costs	0.0	6.5	11.5	29.2	28.6	39.7	49.5	101.0	101.0	188.0	205.1	220.4
Other Operational Support Costs	53.7	131.3	199.4	770.2	782.8	1,250.2	1,311.6	1,625.7	5,281.3	6,110.8	6,237.5	6,341.8
<b>Total Operational Support</b>	<b>1,320.4</b>	<b>1,464.0</b>	<b>4,307.4</b>	<b>5,800.1</b>	<b>6,403.0</b>	<b>7,019.8</b>	<b>7,698.8</b>	<b>8,453.4</b>	<b>14,680.9</b>	<b>17,413.8</b>	<b>18,600.6</b>	<b>27,438.6</b>
<b>Total Operation Costs (Humanitarian Supplies &amp; Materials plus Operational Costs)</b>	<b>1,352.4</b>	<b>1,502.2</b>	<b>4,345.6</b>	<b>5,838.3</b>	<b>6,478.2</b>	<b>7,095.0</b>	<b>7,822.4</b>	<b>8,946.1</b>	<b>14,943.6</b>	<b>24,627.3</b>	<b>25,816.7</b>	<b>34,654.7</b>

Humanitarian Relief Supplies & Materials	27-Mar-11	28-Mar-11	29-Mar-11	30-Mar-11	31-Mar-11	1-Apr-11	2-Apr-11	3-Apr-11	4-Apr-11	5-Apr-11	6-Apr-11	7-Apr-11
Medical Supplies	27.5	27.5	27.5	27.5	42.3	42.3	42.3	42.3	42.3	42.3	45.2	45.2
Health & Comfort Packages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water & Water Storage	219.3	219.3	219.3	219.3	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1
Humanitarian Daily Rations	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	0.0
All Other Humanitarian Relief Supplies	6,965.9	6,997.9	7,314.5	7,314.5	7,277.5	7,290.7	7,290.7	7,290.7	6,947.1	4,950.7	4,951.2	4,952.1
<b>Total Humanitarian Supplies &amp; Materials</b>	<b>7,216.1</b>	<b>7,248.1</b>	<b>7,564.8</b>	<b>7,564.8</b>	<b>7,536.3</b>	<b>7,549.5</b>	<b>7,549.5</b>	<b>7,549.5</b>	<b>7,205.9</b>	<b>5,209.5</b>	<b>5,213.0</b>	<b>5,210.5</b>
Operational Support Costs	27-Mar-11	28-Mar-11	29-Mar-11	30-Mar-11	31-Mar-11	1-Apr-11	2-Apr-11	3-Apr-11	4-Apr-11	5-Apr-11	6-Apr-11	7-Apr-11
Incremental Labor Costs (Includes Civilian Overtime and Contract Labor)	660.0	977.4	1,105.6	1,270.0	1,341.3	1,706.5	1,733.8	2,006.9	2,076.3	1,971.7	2,424.6	2,316.8
Temporary Duty Costs	2,487.5	2,607.0	3,075.1	3,082.9	4,107.0	4,264.2	4,443.0	4,433.2	4,516.0	4,757.6	4,795.1	4,865.5
Health Services, Clothing, & Misc Personnel Support	210.8	210.8	210.8	121.9	155.7	195.2	214.7	214.7	218.9	218.1	209.1	240.4
Base Support (Billeting, mess, C4I, & other support for US forces)	2,639.9	2,639.9	3,213.0	3,417.2	2,703.4	2,703.9	2,703.9	2,703.9	2,703.9	2,703.9	2,703.9	2,655.0
Airlift & Aviation Costs	15,649.5	15,691.5	16,518.2	22,311.6	23,895.5	24,378.2	27,505.3	27,517.3	27,545.7	33,751.5	33,911.7	34,057.8
Sealift & Steaming Costs	6,336.6	6,336.6	7,611.1	8,036.1	8,461.1	8,916.9	9,341.9	9,766.9	10,191.9	10,616.9	11,041.9	11,466.9
Port Handling & Misc Transportation Costs	220.4	233.0	377.0	377.4	288.3	347.4	351.8	351.8	352.6	395.5	397.4	407.5
Other Operational Support Costs	6,346.8	6,437.0	7,221.0	7,340.9	6,846.7	6,200.9	6,305.7	6,390.3	6,619.3	6,368.9	6,364.7	6,431.0
<b>Total Operational Support</b>	<b>34,551.6</b>	<b>35,133.2</b>	<b>39,331.8</b>	<b>45,958.0</b>	<b>47,799.1</b>	<b>48,713.2</b>	<b>52,600.1</b>	<b>53,385.0</b>	<b>54,224.6</b>	<b>60,784.1</b>	<b>61,848.3</b>	<b>62,440.8</b>
<b>Total Operation Costs (Humanitarian Supplies &amp; Materials plus Operational Costs)</b>	<b>41,767.7</b>	<b>42,381.3</b>	<b>46,896.5</b>	<b>53,522.7</b>	<b>55,335.3</b>	<b>56,262.7</b>	<b>60,149.7</b>	<b>60,934.5</b>	<b>61,430.5</b>	<b>65,993.6</b>	<b>67,061.3</b>	<b>67,651.3</b>

Humanitarian Relief Supplies & Materials	8-Apr-11	9-Apr-11	10-Apr-11	11-Apr-11	12-Apr-11	13-Apr-11	14-Apr-11	15-Apr-11	16-Apr-11	17-Apr-11	18-Apr-11	19-Apr-11
Medical Supplies	45.2	45.2	45.2	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
Health & Comfort Packages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water & Water Storage	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1
Humanitarian Daily Rations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Other Humanitarian Relief Supplies	4,952.1	4,952.1	4,952.1	4,952.0	4,952.1	4,952.1	4,952.1	5,320.0	5,320.0	5,320.0	8,880.0	8,880.0
Total Humanitarian Supplies & Materials	5,210.5	5,210.5	5,210.5	5,212.8	5,213.0	5,213.0	5,213.0	5,580.8	5,580.8	5,580.8	9,140.8	9,140.8
Operational Support Costs	8-Apr-11	9-Apr-11	10-Apr-11	11-Apr-11	12-Apr-11	13-Apr-11	14-Apr-11	15-Apr-11	16-Apr-11	17-Apr-11	18-Apr-11	19-Apr-11
Incremental Labor Costs (Includes Civilian Overtime and Contract Labor)	2,384.8	2,383.2	2,406.2	2,419.4	2,475.6	2,563.1	2,613.1	5,078.4	5,080.0	5,080.0	5,125.6	5,104.3
Temporary Duty Costs	5,120.2	5,075.2	5,104.5	5,084.3	5,135.5	5,342.4	4,425.0	5,735.1	5,733.5	5,733.5	5,754.8	5,799.3
Health Services, Clothing, & Misc Personnel Support	230.4	225.4	225.4	227.9	239.8	645.2	645.2	628.8	628.8	628.8	628.8	628.8
Base Support (Billeting, mess, C4I, & other support for US forces)	2,654.6	2,620.6	2,620.6	2,834.0	2,833.8	2,846.2	3,089.6	4,424.4	4,441.3	4,441.3	4,446.0	4,454.3
Airlift & Aviation Costs	36,503.9	36,503.9	36,503.9	36,519.3	37,628.4	38,793.3	38,793.3	40,682.1	40,742.6	42,042.6	43,342.6	43,520.8
Sealift & Steaming Costs	11,907.9	10,805.0	11,165.0	11,525.0	11,885.0	11,885.0	9,322.0	9,322.0	9,350.0	9,350.0	9,350.0	9,350.0
Port Handling & Misc Transportation Costs	407.5	408.0	408.0	394.1	409.5	409.5	414.6	462.0	462.0	462.0	467.2	467.3
Other Operational Support Costs	6,516.6	6,529.7	6,529.7	6,485.3	6,537.7	6,197.5	6,416.2	9,177.9	9,185.5	9,185.5	9,210.3	9,965.1
Total Operational Support	65,725.9	64,551.0	64,963.3	65,489.3	67,145.2	68,682.1	65,719.1	75,510.6	75,623.8	76,923.8	78,325.3	79,289.9
Total Operation Costs (Humanitarian Supplies & Materials plus Operational Costs)	70,936.4	69,761.4	70,173.7	70,702.2	72,358.2	73,895.1	70,932.0	81,091.4	81,204.6	82,504.6	87,466.1	88,430.7

Humanitarian Relief Supplies & Materials	20-Apr-11	21-Apr-11	22-Apr-11	23-Apr-11	24-Apr-11	25-Apr-11	26-Apr-11	27-Apr-11	28-Apr-11	29-Apr-11	30-Apr-11
Medical Supplies	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	87.7	87.7	87.7
Health & Comfort Packages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water & Water Storage	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1	213.1
Humanitarian Daily Rations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Other Humanitarian Relief Supplies	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0	8,560.0
Total Humanitarian Supplies & Materials	8,820.8	8,820.8	8,820.8	8,820.8	8,820.8	8,820.8	8,820.8	8,820.8	8,860.8	8,860.8	8,860.8
Operational Support Costs	20-Apr-11	21-Apr-11	22-Apr-11	23-Apr-11	24-Apr-11	25-Apr-11	26-Apr-11	27-Apr-11	28-Apr-11	29-Apr-11	30-Apr-11
Incremental Labor Costs (Includes Civilian Overtime and Contract Labor)	5,143.7	5,236.8	5,257.2	5,254.6	5,254.6	5,258.9	5,271.6	5,275.3	5,547.0	5,605.7	5,605.7
Temporary Duty Costs	5,925.3	5,624.7	5,632.8	5,625.9	5,625.9	5,625.7	5,656.6	5,650.6	6,013.2	5,997.8	5,997.8
Health Services, Clothing, & Misc Personnel Support	628.8	640.2	629.0	629.0	629.0	929.0	929.0	520.6	520.6	520.6	520.6
Base Support (Billeting, mess, C4I, & other support for US forces)	4,458.5	4,462.7	4,310.6	4,310.6	4,310.6	4,310.2	4,310.2	4,715.7	4,715.7	4,712.2	4,712.2
Airlift & Aviation Costs	43,520.8	36,790.4	36,808.4	36,808.4	36,808.4	36,840.9	38,041.7	38,041.7	38,041.7	38,173.0	38,173.0
Sealift & Steaming Costs	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0	9,350.0
Port Handling & Misc Transportation Costs	467.3	472.4	625.5	625.5	625.5	624.9	624.9	642.9	978.6	978.6	978.6
Other Operational Support Costs	10,293.0	10,297.5	10,271.9	10,271.9	10,271.9	10,313.7	10,330.7	10,334.4	10,692.0	10,596.1	10,596.1
Total Operational Support	79,787.4	72,874.6	72,885.4	72,875.9	72,875.9	73,253.2	74,514.6	74,531.1	75,858.8	75,933.9	75,933.9
Total Operation Costs (Humanitarian Supplies & Materials plus Operational Costs)	88,608.2	81,695.4	81,706.2	81,696.7	81,696.7	82,074.0	83,335.4	83,351.9	84,719.6	84,794.6	84,794.6

## APPENDIX E. 2012 DHL WARFIGHTERS CONTRACT RATES FOR THEATERS

The below table is provided as 2012 DHL warfighters contract rates for particular Combatant Command theaters. For example, to calculate the rate for a 155 lb shipment from Conus to a Southern Theater Zone A location, multiply the "150-300" rate (\$1.28 USD) x 155lb = \$198.40 USD. (Dalsey, Hillblom and Lynn (DHL) Worldwide Express, 2012)

STD WWX-5 Contract Rates									
Weight lbs TT (Ltr, ISPX, IHX)	Southern Theater		European Theater			Central Theater		Pacific Theater	
	A	B	C	D	E	F	G	H	I
0.5	\$ 13.13	\$ 19.64	\$ 15.02	\$ 18.92	\$ 38.27	\$ 14.33	\$ 37.57	\$ 12.22	\$ 12.67
1	\$ 17.65	\$ 24.27	\$ 17.50	\$ 25.68	\$ 45.00	\$ 18.07	\$ 44.19	\$ 13.62	\$ 14.74
2	\$ 19.12	\$ 32.75	\$ 18.75	\$ 29.74	\$ 53.45	\$ 21.47	\$ 52.50	\$ 15.70	\$ 17.17
3	\$ 20.58	\$ 38.80	\$ 20.62	\$ 32.79	\$ 60.02	\$ 25.05	\$ 60.85	\$ 16.72	\$ 19.62
4	\$ 22.04	\$ 44.85	\$ 24.25	\$ 35.40	\$ 68.22	\$ 28.62	\$ 68.99	\$ 18.24	\$ 21.27
5	\$ 23.49	\$ 50.90	\$ 27.89	\$ 39.34	\$ 76.39	\$ 34.19	\$ 76.87	\$ 19.78	\$ 23.72
6	\$ 24.95	\$ 56.95	\$ 30.63	\$ 64.23	\$ 84.28	\$ 37.29	\$ 81.94	\$ 21.32	\$ 26.14
7	\$ 26.42	\$ 63.00	\$ 33.08	\$ 70.78	\$ 90.60	\$ 40.05	\$ 88.99	\$ 22.87	\$ 28.79
8	\$ 27.87	\$ 69.05	\$ 36.75	\$ 77.33	\$ 96.97	\$ 42.42	\$ 95.79	\$ 24.39	\$ 31.43
9	\$ 29.33	\$ 73.94	\$ 40.44	\$ 82.57	\$ 103.30	\$ 45.97	\$ 102.38	\$ 25.75	\$ 34.85
10	\$ 34.05	\$ 78.78	\$ 46.54	\$ 86.22	\$ 109.63	\$ 48.33	\$ 108.75	\$ 28.03	\$ 37.85
149	\$ 190.24	\$ 561.50	\$ 333.79	\$ 619.09	\$ 905.82	\$ 431.93	\$ 885.44	\$ 328.98	\$ 402.92
150	\$ 191.55	\$ 565.27	\$ 336.04	\$ 623.25	\$ 911.90	\$ 434.83	\$ 891.38	\$ 331.19	\$ 405.62
151-300	\$ 1.28	\$ 3.32	\$ 2.25	\$ 4.16	\$ 6.08	\$ 2.90	\$ 5.95	\$ 2.21	\$ 2.71
301+	\$ 1.11	\$ 3.30	\$ 2.16	\$ 3.38	\$ 5.58	\$ 2.70	\$ 4.45	\$ 1.55	\$ 2.41
Note: For shipments over 150 lbs you can calculate the rate by multiplying the total weight by the rate per pound.									



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## APPENDIX F. PEAK SPEND PLAN (FY 2010)

The below table is provided as FY 2010 PEAK spend plan. The table includes the PEAK JCTD functional cost estimates for operational, technical, and transition tasks for FY 2010, FY 2011, and FY 2012. (Office of the Secretary of Defense, 2010a)

<b>PEAK JCTD Functional Cost Estimation (\$ Thousands)</b>				
<b>Task / Item</b>	<b>FY10</b>	<b>FY11</b>	<b>FY12</b>	<b>TOTAL</b>
<b>Operational</b>				
Operational Management	\$130	\$180	\$45	\$355
Concept of Operations (CONOPS) / Tactics, Techniques, Procedures (TTPs)	\$35	\$0	\$0	\$35
Requirements Analysis and Documentation	\$40	\$0	\$0	\$40
Demonstrations and Assessments	\$30	\$145	\$0	\$175
Joint / Operational Utility Assessment Reports	\$80	\$120	\$20	\$220
<b>Operational Total Estimate</b>	<b>\$315</b>	<b>\$445</b>	<b>\$65</b>	<b>\$825</b>
<b>Technical</b>				
Project Management	\$50	\$250	\$0	\$300
Technical Support	\$360	\$360	\$90	\$810
Knowledge Repository – Integration, Hosting, Maintenance, ICDs, Specifications	\$60	\$0	\$0	\$60
Contracting & Related Costs	\$130	\$40	\$20	\$190
Analysis of Alternatives and Kit Design	\$60	\$0	\$0	\$60
Kit Integration	\$120	\$200	\$0	\$320
Kit Procurement	\$1,040	\$1,105	\$40	\$2,185
Demonstrations and Assessments	\$375	\$300	\$0	\$675
Training Plans & Packages	\$40	\$0	\$30	\$70
Travel	\$60	\$90	\$30	\$180
<b>Technical Total Estimate</b>	<b>\$2,295</b>	<b>\$2,345</b>	<b>\$210</b>	<b>\$4,850</b>
<b>Transition</b>				
Transition Planning	\$0	\$50	\$60	\$110
Travel	\$0	\$10	\$10	\$20
(Interim) Capability Sustainment	\$0	\$0	\$20	\$20
<b>Transition Total Estimate</b>	<b>\$0</b>	<b>\$60</b>	<b>\$90</b>	<b>\$150</b>
<b>Estimated Total Cost</b>	<b>\$2,610</b>	<b>\$2,850</b>	<b>\$365</b>	<b>\$5,825</b>

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## LIST OF REFERENCES

- Apte, A. U. (2009). Humanitarian Logistics: A New Field of Research and Action. *Foundations and Trends in Technology, Information and Operations Management*, 3(1), 1–100. Retrieved from <http://libguides.nps.edu/content.php?pid=125051&sid=1076553>
- Balling, Frederick O. (2009, June). Army Portable Water Treatment Units PowerPoint presentation.
- Boland, Rita. (2011). Disaster Response Is Reaching Pre-positioned Expeditionary Assistance Kit (PEAK). Retrieved from [http://www.afcea.org/signal/articles/templates/SIGNAL\\_Article\\_Template.asp?articleid=2635&zoneid=164](http://www.afcea.org/signal/articles/templates/SIGNAL_Article_Template.asp?articleid=2635&zoneid=164)
- Brown, Darrell H. (2011, December). The Impact Of Rechargeable Batteries: Quantifying The Cost And Weight For A Marine Infantry Battalion. M.S. thesis, Naval Postgraduate School, Monterey, CA.
- Chairman of the Joint Chiefs of Staff. (2011). National Military Strategy of the United States of America. Retrieved from [www.jcs.mil//content/files/2011-02/020811084800\\_2011\\_NMS\\_-\\_08\\_FEB\\_2011.pdf](http://www.jcs.mil//content/files/2011-02/020811084800_2011_NMS_-_08_FEB_2011.pdf)
- Clement, Tommy J. (2012, June). Cost Benefit Analysis of a Utility Scale Waste-to-Energy/Concentrating Solar Power Hybrid Facility at Fort Bliss. M.S. thesis, Naval Postgraduate School, Monterey, CA.
- Dalsey, Hillblom and Lynn (DHL) Worldwide Express. (2012, June). 2012 Warfighters Contract Rates for Theaters.
- Defense Acquisition University. (2004). Advanced concept technology demonstrations. Retrieved from <https://acc.dau.mil/CommunityBrowser.aspx?id=37609&lang=en-U.S>
- Defense Acquisition University. (2006). Program Managers Business Case Analysis Guide. Retrieved from <http://www.dau.mil/search/search.aspx?q=breakeven+point>
- Defense Acquisition University. (2007). Business Case Analysis. Retrieved from <https://acc.dau.mil/CommunityBrowser.aspx?id=527152>
- Defense Acquisition University. (2008a). Life-Cycle Cost (LCC). Retrieved from <https://acc.dau.mil/CommunityBrowser.aspx?id=241468>
- Defense Acquisition University. (2008b). Program of Record (POR). Retrieved from <https://dap.dau.mil/glossary/pages/2492.aspx>

- Denning, Peter J. ( 2006). The Profession of IT, Communications of the ACM, April 2006/Vol. 49, No. 4. Retrieved from [http://faculty.nps.edu/dl/HFN/documents/HastilyFormedNetworks\\_Denning.pdf](http://faculty.nps.edu/dl/HFN/documents/HastilyFormedNetworks_Denning.pdf)
- Department of Defense Instruction 3000.05. (2009, September). Stability Operations.
- Department of Defense Instruction 5000.02 (2008, December). Operation of the Defense Acquisition System
- Department of the Army. (2009). Warfighter Capabilities Determination, Retrieved from <http://www.fas.org/irp/doddir/army/ar71-9.pdf>
- Department of the Navy. (2007). A Cooperative Strategy for 21<sup>st</sup> Century Seapower.
- Emergency Events Database (EM-DAT). (2011, February). The international disaster database. Retrieved from <http://www.emdat.be/database>
- Federal Emergency Management Agency (FEMA). (2010, January). FEMA. Retrieved from <http://www.fema.gov/index.shtm>
- Greenfield, C.M, Ingram, C.A. (2011). An Analysis of U.S. Navy Humanitarian Assistance and Disaster Relief Operations. Retrieved from [http://edocs.nps.edu/npspubs/scholarly/MBAPR/2011/June/11Jun\\_Greenfield\\_MBA.pdf](http://edocs.nps.edu/npspubs/scholarly/MBAPR/2011/June/11Jun_Greenfield_MBA.pdf)
- Hastily Formed Network. (2010). Retrieved from <http://faculty.nps.edu/dl/HFN/index.htm>
- Honegger, Barbara. (2010). NPS Hastily-Formed Networks research group responds to Haiti earthquake. Retrieved from <http://www.nps.edu/About/News/NPS-Hastily-Formed-Networks-Research-Group-Responds-to-Haiti-Earthquake.html>
- Horn, R. (2011). Pre-Positioned Expeditionary Assistance Kit (PEAK) Joint Capability Technology Demonstration. Retrieved from <http://www.commondefensequarterly.com/archives/CDQ10/peak.html>
- Horngren, C. T., Datar, S. M., & Foster, G. (2006). Cost Accounting: A Managerial Emphasis. 12th ed. Saddle River, NJ: Pearson Education, Inc.
- Joint Capability Technology Demonstrations. (2011). Joint Capability Technology Demonstration (JCTD) Program overview. Retrieved from <http://www.acq.osd.mil/jctd/overview.html>

- Kolar, Ramesh. (2012, June). Business Case Analysis Of Medium Altitude Global ISR Communications (MAGIC) UAV System. M.S. thesis, Naval Postgraduate School, Monterey, CA.
- Leewright, Corey K. (2012, September). A Cost-Benefit Analysis Of The Smart Power Infrastructure Demonstration For Energy Reliability And Security (SPIDERS). M.S. thesis, Naval Postgraduate School, Monterey, CA.
- Marine Corps Systems Command. (2003). End Item Procurement (EIP) and Average Unit Cost (AUC), Enhanced Reverse Osmosis Water Purification Unit (EROWPU) Cost Element Estimating Guide. Retrieved from <https://dap.dau.mil/policy/Documents/Policy/ca0d3.rtf>
- Marine Corps Systems Command. (2008, August). Generator Set, Diesel Engine, Model MEP-531A. Retrieved from <http://www.marcorsyscom.usmc.mil/sites/pmeps/DOCUMENTS/2kWMilitaryTacticalGenerator.pdf>
- Marine Corps Systems Command (2009, May). Joint Service Power EXPO United States Marine Corps Expeditionary Power Systems PowerPoint presentation.
- National Defense University. (2010, July). Pre-positioned Expeditionary Assistance Kit (PEAK) Joint Capability Technology Demonstration (JCTD) Technical Specifications.
- National Defense University. (2011, January). Pre-positioned Expeditionary Assistance Kit (PEAK) Joint Capability Technology Demonstration (JCTD) Business Case Analysis.
- National Military Strategy of the United States of America. (2011, July). Redefining America's Military Leadership.
- Naval Center for Cost Analysis. (2012). The Joint Inflation Calculator for FY2012. Retrieved from <https://www.ncca.navy.mil/tools/inflation.cfm>
- Naval Postgraduate School. (2012). Cost Estimating and Analysis: Economic Analysis and Time Value of Money PowerPoint presentation.
- Naval Sea Systems Command. (2005, September). A Program Manager's Guide to Conducting Performance Based Logistics (PBL) Business Case Analysis (BCA).
- NEST Energy Systems. (2011). Raptor Solar Light Trailer. Retrieved from <http://www.nestenergysystems.com/lighting.htm>

- Office of Assistant Secretary of Navy Financial Management and Comptroller. (2011, May). Cost Report Japanese Earthquake Relief.
- Office of Management and Budget. (2012, January). 2012 Discount Rates for OMB Circular No. A-94. Retrieved from <http://www.whitehouse.gov/sites/default/files/omb/memoranda/2012/m-12-06.pdf>
- Office of the Chairman of the Joint Chiefs of Staff. (2011). Joint Pub 3.07, Stability Operations, September 2011. Retrieved from [http://www.dtic.mil/doctrine/new\\_pubs/jp3\\_07.pdf](http://www.dtic.mil/doctrine/new_pubs/jp3_07.pdf)
- Office of the Secretary of Defense (OSD). (2010a, August). Pre-positioned Expeditionary Assistance Kit (PEAK) Joint Capability Technology Demonstration (JCTD) Management Plan.
- Office of the Secretary of Defense (OSD). (2010b). Pre-positioned Expeditionary Assistance Kit (PEAK) PowerPoint presentation.
- Office of the Under Secretary of Navy Comptroller. (2010, November). DoD standard composite pay rates FY 2011. Retrieved from [http://comptroller.defense.gov/rates/fy2011/2011\\_k.pdf](http://comptroller.defense.gov/rates/fy2011/2011_k.pdf)
- Secretary of Defense. (2010). Quadrennial Defense Review Report. Retrieved from [http://www.defense.gov/qdr/images/QDR\\_as\\_of\\_12Feb10\\_1000.pdf](http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf)
- Seng, C. C. (2008). A Business Case Analysis of the Hard Target Void Sensing Fuze (HTVSF) Joint Capability Technology Demonstration (JCTD). M.S. thesis, Naval Postgraduate School, Monterey, CA.
- United States Agency for International Development. (2009a). USAID Disaster Assistance Annual Reports. Retrieved from [http://www.usaid.gov/our\\_work/humanitarian\\_assistance/disaster\\_assistance/publications/annual\\_reports/index.html](http://www.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/publications/annual_reports/index.html)
- United States Agency for International Development. (2009b). Office of U.S. Foreign Disaster Assistance Funding Summary (FY 2009). Retrieved from <http://www.usaid.gov/what-we-do/working-crises-and-conflict/crisis-response/resources/annual-reports>
- United States Agency for International Development Annual Reports. (2010). Office of U.S. Foreign Disaster Assistance Funding Summary (FY 2010). Retrieved from <http://www.usaid.gov/what-we-do/working-crises-and-conflict/crisis-response/resources/annual-reports>

United States Marine Corps Systems Command. (2009, April). Approved Power Source Lists Approved Mobile Electric Power Tactical Generators. Marine Corps Base Quantico, Triangle, VA.

United States Southern Command. (2010a, September). Pre-positioned Expeditionary Assistance Kit (PEAK) Concept of Operations.

United States Southern Command. (2010b, November). Pre-positioned Expeditionary Assistance Kits Joint Capability Technology Demonstration.



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